Online ISSN : 2249-4626
Print ISSN : 0975-5896
DOI : 10.17406/GJSFR

Global Journal

of Science Frontier Research: A

Physics and Space Science

Atomic-Molecular Structure

Network in Tropical Zones

Highlights

Dark Matter Fractal Field

Coherence Meditation Techniques

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 1 VERSION 1.0

Global Journal of Science Frontier Research: A
Physics & Space Science

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Physics & Space Science
Volume 20 Issue 1 (Ver. 1.0)

Open Association of Research Society

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USA Tax ID: 98-0673427

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Global Journal of Science Frontier Research

Contents of the Issue

Global Journal of Science Frontier Research: a
Physics and Space Science
Volume 20 Issue 1 Version 1.0 Year 2020
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Atomic-Molecular Structure of Substances and Energy Manifestations

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Abstract- At the International Congress of Chemists in 1860 in Karlsruhe (Germany), the concepts of the molecule and atom that make up the substance were adopted. The property of matter consisting of these interconnected particles is mainly characterized by mass, which expresses a measure of inertia and energy - a measure of its motion. For the rational use and management of forms of energy transfer is interesting to clarify the nature of elementary matter in the atomic-molecular structure of substances, i.e. elementary particles constituting internal energy. Based on the analysis of scientific and experimental data published in the press, it can be concluded that the elementary particles called photons, “theplotrons”, “electromagnetic particles”, “electromagnetic waves” or others shows that they are elementary “material objects” depending on the condition and of the character of movement are manifested in the various forms of energy transfer. It should be noted that the release of heat, light, electromagnetic waves or others depends on the nature of substances containing in the atomic-molecular structure "elementary particles" formed from various ratios of "magnetic and electrical components".

Keywords: matter, energy, elementary particle, electron, “theplotron”, photon, electromagnetic field, “electro- magnetic particle”, “chemical individual”.

GJSFR-A Classification: FOR Code: 020299

Strictly as per the compliance and regulations of:

Atomic-Molecular Structure of Substances and Energy Manifestations

B. T. Utelbayev [α], E. N. Suleimenov [σ] & A. B. Utelbayeva [ρ]

Abstract- At the International Congress of Chemists in 1860 in Karlsruhe (Germany), the concepts of the molecule and atom that make up the substance were adopted. The property of matter consisting of these interconnected particles is mainly characterized by mass, which expresses a measure of inertia and energy - a measure of its motion. For the rational use and management of forms of energy transfer is interesting to clarify the nature of elementary matter in the atomic-molecular structure of substances, i.e. elementary particles constituting internal energy. Based on the analysis of scientific and experimental data published in the press, it can be concluded that the elementary particles called photons, "theplotrons", "electromagnetic particles", "electromagnetic waves" or others shows that they are elementary "material objects" depending on the condition and of the character of movement are manifested in the various forms of energy transfer. It should be noted that the release of heat, light, electromagnetic waves or others depends on the nature of substances containing in the atomic-molecular structure "elementary particles" formed from various ratios of "magnetic and electrical components". These elementary particles were called by us conventionally "electromagnetic particles", which participate in the structurally – energy correspondence of "chemical individuals" of substances. Transition a system from one state to another is carried out by the movement of electrons and elementary "electromagnetic particles" of substances combined in the atomic-molecular structure. The data presented by us in this article lead to conclude that in the structure of atoms there are containing combined elementary particles characterizing energy as a measure of the movement of them and require revise the structure of substances.

Keywords: matter, energy, elementary particle, electron, "theplotron", photon, electromagnetic field, "electro-magnetic particle", "chemical individual".

I. Introduction

It is well known that scientific achievements in the field of atomic-molecular structure of substances have revealed unusual properties of micro-objects [1-6], which affect on the characteristic of macroscopic formations. However, near the boundary of the value of Planck's constant, it is difficult to judge the forms and structures of micro-objects, which is complicated by the lack of the possibility of direct instrumental measurements. In our discussion we proceeded from the thesis formulated by M. Faraday on the identity of energy manifestations in the interaction of material objects. Given the interconnectedness of micro-macroscopic properties, the inductively-deductive character of the information, and based on the logical sequence of the laws of structural-energetic correspondence of the constituent elements mathematical calculations are made, hypotheses are formulated, "definitions" of phenomena and others are accepted to describe the objective reality of the system under consideration. According to modern concepts, a substance consists of interconnected atoms-electroneutral particles consisting of a positively charged nucleus and negatively charged electrons [4-9]. In turn, the properties of matter are mainly characterized by mass, which expresses a measure of inertia and energy- a measure of its motion. In the relative rest of substances, its state is described by internal energy- a general characteristic of the constituent elements of a given system. The change of internal energy affect to the state of a system, which manifest in the form of energy transfer- the performance of work and appear as heat, light, electricity, magnetism, etc. In these processes the nuclear-electronic structure of substances plays an important role, where an increase the charge of the atomic nucleus, the structure of the electron shell changes periodically, which leads to a periodic change in their properties. However, all the details of the role of electrons and their distribution in the atomic-molecular structure of substances are still unknown. Regarding modern theories about atomic structures, we can say that they are too cluttered with complex calculations and assumptions, which, in our opinion, need significant refinement. This article discusses these issues based on real processes taking place in the environment.

II. Discussion

Despite the similarity of the structures of atoms consisting of protons, neutrons and electrons, a set of certain quantities individualizes of them which form a molecular or non-molecular structure of this compound between themselves or other atoms. The presence of compounds of the nonmolecular structure led to different interpretations, and this in [8] it is noted as follows: "... due to the fragmentation of chemistry into many "separate" disciplines, different authors use different versions of it as the most important basic fundamental concept, such as "chemical individual",

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"molecule", "chemical compound", "chemical substance", etc., which applies to all substances formed from atoms". And for the correct perception of objective reality, clarity should be introduced into the concept expressing the states and structures of atoms in a chemical bond and their compounds formed. First of all, it is necessary to accept that atoms in a chemically bound form do not exhibit their individual atomic properties and are in the state of "chemical elements" [8]. If we assume that molecules are formed from chemical elements as the smallest particle of a substance possessing all its physical and chemical properties, then this definition does not include compounds of a non-molecular structure. In this regard, for a general discussion of the micro-macroscopic properties of material formations, regardless of the molecular or non-molecular structure, we propose the concept of "chemical individual" in the following version [7]:

A "chemical individual "represents a unit cell of a lattice of condensed matter or a minimal group of chemical elements connected in the form of chemical, metal, coordination and intermolecular bonds that determine the properties of a macroscopic system.

According to the scientific literature electrons play a significant role in chemical and intermolecular bond formations, however, the gaps noted in [9] and the processes occurring in reality require a review of the role of electrons and the atomic-molecular structure of substances. For example, electrons are the commonly accepted carriers of electricity in metals; under voltage, EMFs move at approximately $1{\cdot}10^{-4}$ - $1{\cdot}10^{-5}$ m / s. However, it is known that the speed of an electron in electric current is very differ from the speed of the electric field, which must have been created by the electrons. Electricity as a form of energy transfer usually represents an electric current, which represent the ordered movement of charged particles, and in metals generally electrons are accepted [10]. In practice, despite the insignificant speed of the electron, regardless of the distance of the source generating EMF, an electromagnetic field and an electric current appear along the entire length of the conductor. In this regard, it is necessary to find out the participation of the electron and the electromagnetic field in the creation of the electric current. For example, in [11] for a copper conductor the electron velocity (*v)* was calculated by the formula:

$$v = I\mu / qdN_AS$$

Where *I* is the current strength, μ is the molar mass of the conductor, *q* is the electron charge, *d* is the density of the conductor, N_A is the Avogadro number and *S* is the cross-section of the conductor. The Substitution of the numerical values from the reference material characteristic of copper gives the value of the electron velocity $\approx 5{\cdot}10^{-5}$ m/s, while the alternating electric current goes without changing the "chemical individual" of the conductor. Similarly, to calculate the electron velocity at constant current, we used the data of galvanizing iron with an area of 1000 cm^2 at a current strength of 2.5 A and a zinc density of 7.15 g / cm^3 [12]. Our calculation according to the above formula gives the following value for the electron velocity:

$$v = 2.5{\cdot}0.0327 / 1.6{\cdot}10^{-19} \cdot 7.15 \cdot 10^3 \cdot 6.02{\cdot}10^{23} \cdot 1{\cdot}10^{-1} \approx 1.1 \cdot 10^{-9} \text{ m / s.}$$

Therefore, during electrolysis, the electron velocity is $1.1{\cdot}\ 10^{-9}$ m / s and the transition time from one lattice to another is $2{\cdot}10^{-10}$ / $1.1{\cdot}10^{-9}$ = 0.18 s. The calculated electron velocity along the conductor is $\approx 5{\cdot}10^{-5}$ m /s and the electron transition time from one lattice (distance $2 \cdot 10^{-10}$ m) to another is approximately $2{\cdot}10^{-10}$ / $5{\cdot}10^{-5}$ = $4{\cdot}10^{-6}$ s. This value, compared with 0.18s is very insignificant, i.e., the limiting stage of electrolysis is the inhibition of the heterogeneous-heterophase electrochemical reaction at the electrode-solution interface, phase transitions and rearrangement of the crystal lattices of metals determining the electrochemical kinetics of the process. All these experimental data are in favor of the fact that in the atomic structure of the conductor, in addition to the nuclear – electronic component, there should be some "elementary particle" responsible for creating an electric field, which stimulates the flow of displacement of charged particles and the appearance of an electric current.

In [9], authors believe that the carriers of electricity are electrons bound into rigid complexes with a magnetic field. According to this view when to a conductor a voltage is applied, an electric field propagates along it at the speed of light and interacts with conduction electrons causing them to move. As a result of the motion a magnetic field is excited, and form a single complex "electron - magnetic field" which move at speed equal of light. With this approach, at an alternating current frequency of 50 Hz and at the speed of light, the proposed "magnetic field-electron" complex travels a distance in a single oscillation:

$$3 \cdot 10^8 \text{ (m / s): 50 } (s^{-1}) = 6 \cdot 10^6 \text{ m}$$

Thus the electric current carrier - electron - is located not only outside the lattice structure of the conductor (approximately a distance of $2{\cdot}10^{-10}$ m, but to be from the conductor at decent distances destroying its lattice. The reality shows that the transmission of electricity with alternating current is carried out using constituent elements of the conductor without their destruction.

In [13], it is stated that electric current is transported through the wire by electromagnetic waves, and not by the movement of electrons. However, the waves are the trajectory of material substance, and the

material nature of the wave components of the components of the electromagnetic field remains unknown. The propagation of the electromagnetic field in a conductor depends on its dielectric (ε) and magnetic (μ) permeability and in $(\varepsilon\mu)^{1/2}$ less speed compared to vacuum. For a copper conductor, the dielectric constant (ε) is 978, and the magnetic permeability (μ) 0.999 and the propagation velocity of the electromagnetic field (v) along the copper conductor is:

$$v = s / (\varepsilon\mu)^{1/2} = 3 \cdot 10^8 / (978 \cdot 0.999)^{1/2} = 3 \cdot 10^8 / 31.26 = 0.959 \cdot 10^7 \text{ m /s.}$$

The calculated velocity of $0.959 \cdot 10^7$ m / s compared with the electron velocity of $1 \cdot 10^{-4}$ - $1 \cdot 10^{-5}$ m / s differs by 11 - 12 orders of magnitude and, therefore, electrons at this speed cannot create an electromagnetic field. This means that in the atomic-molecular structure of the conductor there is a certain “material object” containing a “magnetic and electric component”, which creates an electromagnetic field under the influence of the EMF of the source. That is, under the influence of the EMF of the source, the electrical component of the “material object” undergoes polarization creating a potential difference, and the moving component is affected by the magnetic component enhancing the polarization. An electro-magnetic field is created along the conductor, which induces the movement of valence electrons in the nuclear - electronic system. The alternating direction of the electromagnetic field leads to the oscillatory motion of the valence electrons of the conductor. For one oscillation at an AC frequency of 50 Hz and an electron velocity of $5 \cdot 10^{-5}$ m / s, the electron travels a distance of$5 \cdot 10^{-5}$: 50 = $1 \cdot 10^{-6}$ m, which is much larger than the lattice parameter, i.e., this length corresponds to approximately $1 \cdot 10^{-6}$m: $2 \cdot 10^{-10}$m = $5 \cdot 10^3$ the number of gratings. The transition of an electron from one lattice (distance $2 \cdot 10^{-10}$ m) to another requires approximately $2 \cdot 10^{-10} / 5 \cdot 10^{-5} = 4 \cdot 10^{-6}$ s. When implementing the sequential mechanism of the electron transition through the lattice, in one alternating current oscillation, the electron overcomes $5 \cdot 10^3$ lattice parameters in a time of $5 \cdot 10^3 \cdot 4 \cdot 10^{-6} = 2 \cdot 10^{-2}$ s, and by the simultaneous electron transition $4 \cdot 10^{-6}$ s is enough. Therefore, in spite of the insignificant electron velocity of $5 \cdot 10^{-5}$ m / s, the creation of an alternating electric current with a frequency of 50Hz along the entire length of the conductor from the source to the destination requires time from $4 \cdot 10^{-6}$ to $2 \cdot 10^{-2}$ s. It is possible as a result of the creation of an electromagnetic field - a driving force for the movement of electrons by the relay mechanism along the entire length of the conductor. Moreover, practice shows that the structure of the “chemical individual” of the conductor does not change with alternating current, and the value of the self-induction EMF ($\mathcal{E}_{ind}$) is expressed by the well-known equality [14]:

$$\mathcal{E}_{ind} = -LdI / dt$$

Where, L- circuit inductance or self-induction coefficient, the value of which depends on the geometric properties of the circuit and of the nature containing magnetic components; dI / dt - an infinite small change in current strength over time. The movement of charges takes the work determined by the product of IU per unit time, and Ohm's law at each moment of time matters:

$$IR = \mathcal{E}_{stor} + \mathcal{E}ind = \mathcal{E}_{stor} - LdI / dt.$$

Consequently, the participants in the electric current are the elementary "material substance" in *the* atomic-molecular structure of the "chemical individual" created by the electromagnetic field under the influence of the EMF source and inducing the movement of electrons through the conductor.

According to modern scientific literature, an electromagnetic field is the propagation of electromagnetic waves in space and time. The propagation of electromagnetic waves is described by Maxwell's equations [15], and the existence of “electromagnetic waves” was experimentally proved by the works of Heinrich Hertz [16], where it is argued that the rays of the sun also represent electromagnetic waves.

In the case of an electric current, under the influence of an electromagnetic field, the electron shifts from its stationary position until the potential difference in the nuclear - electronic structure is compensated by the external EMF source. A variable direction EMF the source leads to oscillatory motion of electrons performing electrical work accompanied by energy manifestations in the form of release (absorption) of heat, light, electromagnetic waves, etc. [17]. These energetic manifestations mean that elementary “material substances” are distinguished from the atomic-molecular structure of the “chemical individual”. For example, the light pressure predicted by Maxwell was experimentally discovered and measured by the Russian physicist P. N. Lebedev. The pressure of electromagnetic radiation is a consequence of the fact that, like any material object characterizing the energy ε and moving at the speed of light, it has a momentum $p = \varepsilon / c$. This formula allows us to determine the mass of a photon as a kind of “electromagnetic particle”, where according to the spectroscopic data of optics for visible light, its frequency varies from $3.31 \cdot 10^{14}$ to $7.81 \cdot 10^{14}$Hz. It is known from the Planck equation that $\varepsilon = hv$, and the momentum of a material particle is equal to the product of its mass (m) and velocity (v):

$$p = mv$$

At a particle speed equal to the speed of light, we write the formula for the photon momentum in the form (Compton effect):

$$p = mc.$$

In these cases, the equality is true:

$$mc = hv / c \ \ (i.e., mc^2 = hv) \text{ and } m = hv / c^2$$

Substitution of numerical values from the reference literature into the formula gives the mass of a photon at the corresponding frequencies:

$$m = 6.62 \cdot 10^{-34} \cdot 3.31 \cdot 10^{14} / (3 \cdot 10^8)^2 = 2.43 \cdot 10^{-36}\text{kg}$$

$$m = 6.62 \cdot 10^{-34} \cdot 7.81 \cdot 10^{14} / (3 \cdot 10^8)^2 = 5.43 \cdot 10^{-36}\text{kg}$$

In [18-22], based on the basis of thermodynamic and quantum - mechanical representations, we proposed a hypothesis about heat carriers - "thermotrons" and calculated its mass. Based on the classical equations of physics (quantum mechanics), the mass of the photon and the "thermotron" were calculated [22]. The data numbers $2.43 \cdot 10^{-36}$kg and $5.43 \cdot 10^{-36}$kg are close to the mass of "theplotrons" $5.27 \cdot 10^{-36}$kg, which we calculated using thermodynamic data for hydrogen combustion and exactly coincides with the calculations. Similarly, when performing work (chemical, biological, electrochemical, etc.), the movement (redistribution) of electrons and elementary particles with the same energy manifestations is characteristic. In all these changes, the number of electrons involved in the process before and after remains constant and only their redistribution occurs between the structural elements of the "chemical individuals", and elementary particles representing their energy movements are scattered in the environment forming combinations with their components.

In [23], M. Faraday pointed out that regardless of the thermal, light, chemical, physiological, magnetic or mechanical source of energy, all of them can manifest themselves in the form of the same electricity. This conclusion of M. Faraday means the identity of the nature of elementary particles representing the concept of "energy" (electric, magnetic, light, thermal, etc.) by their movements. The preceding allows us to state that the noted "elementary particles" representing "energy" are contained in the atomic-molecular structure of substances and are in dynamic equilibrium with the environment. And the question arises: "*In what form are these particles in the atomic-molecular structure of the*" *chemical individual* "? For example, a photon and a "theplotron" which are carriers of light and heat, and why are they not explicitly detected in the composition of substances? On this question answer the elementary particles themselves participating in the connection between the structural elements of the "chemical individual". Let us consider the interactions of gaseous hydrogen with oxygen, where the redistribution of their structural elements in combination gives water, i.e., they turn into constituent elements of water and, as simple substances hydrogen and oxygen are not contained in water. However, if necessary, they can be obtained by decomposing water. Similarly, the sun's energy absorbed by plants, when they burn, it is again released in the form of heat and light. A clear example of a combination of elementary particles is the dispersion rays of the sun, where a colorless ray is decomposed into monochromatic components by passing through a prism [24]. In a similar way, the elementary "material objects" characterizing the concept of "energy" form combinations in the atomic-molecular structure of the "chemical individual" of a substance [25-27]. When external energy applied to the system, the combination decays and "elementary particles" are released, which manifests itself in the form of heat, light, etc. For micro-objects near the boundary, the Planck's value is difficult to determine with the structure and form of the elementary "material objects" and in the scientific literature this concept is presented in different ways: in the form of a "particleless form" [28], "particle-field dualism of Matter" [30], "particle -wave dualism" [30] and others. *In this regard, the motion of elementary substances called photons," theplotrons", "electromagnetic particle ", "electromagnetic wave "or others are the same objects of matter, which, depending on the conditions and the actor's movements are manifested in various forms of energy transfer.* It should be noted here that the release of heat, light, electromagnetic waves or others depends on the nature of substances containing in the atomic-molecular structure "elementary particles" formed from various ratios of "magnetic and electrical components" conventionally called by us "electromagnetic particles" [18-22, 25-27, 31-33]. The content of the "magnetic and electrical components" in the "electromagnetic particle" gives them a rotationally pulsating motion [32–33], which determines the structural and energy stability of the "chemical individuals" and is reflected in the physicochemical properties of the substance as a whole. And these data characterize that the photon as a kind of "electromagnetic particle does not have a rest mass. Usually radiation frequencies of electromagnetic waves, in fact, represent the frequency of pulsations of the "electromagnetic particle" as result interaction of "electrical and magnetic components" containing in it.

III. Conclusion

We used the thesis of M. Faraday on the identity of energy manifestations in the interaction of material objects. The views expressed in this article and in our other publications about the transfer of energy between material objects and their manifestation in various forms require a revision of the atomic-molecular structure of substances taking into account the combined elementary particles characterizing the energy as a measure of the movement of "electromagnetic particles".

The transfer of energy characterizes performance of work accompanied by energy manifestations, depending on the conditions created

from the outside to the system, strictly in accordance by the universal law of conservation of matter and energy conversion.

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Global Journal of Science Frontier Research: a
Physics and Space Science
Volume 20 Issue 1 Version 1.0 Year 2020
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Remote Sensing Network in Tropical Zones for Lightning Monitoring

By Horacio Torres & Daniel Aranguren

National University of Colombia

Abstract- The aim of this letter is to introduce the Tropical Network of Remote Sensors (TRONSE), which is composed of Total Lightning Detection Systems - TLDS, electrostatic field sensors registered in Colombia as PreThor, and an information management system developed to monitor lightning activity in Tropical regions. These networks are part of the research work contributing to the analysis of magnitudes of the lightning parameters within the spatial concept and for applications in lightning protection in tropical areas. Several research results have shown the influence of latitude in the lightning phenomena and how the magnitude of lightning parameters is not necessarily valid in geographical zones all over the world. They are different in tropical latitudes to those in temperate ones.

Keywords: lightning in tropical zones, lightning remote sensing, spatial variations of lightning parameters.

GJSFR-A Classification: FOR Code: 090905

Strictly as per the compliance and regulations of:

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Horacio Torres [α] & Daniel Aranguren [σ]

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Keywords: lightning in tropical zones, lightning remote sensing, spatial variations of lightning parameters.

I. Introduction

Modern research on the physics of lightning began in the early 20th century with the work of Wilson [1]. In the global circuit context, Wilson first suggested that thunderstorms are charge pumps, which maintain the potential difference between the Earth's surface and the upper atmosphere (the ionosphere's potential). Whipple [2] compared the diurnal variation in Brooks' results [3] and in the initial electric field measurements over the ocean, thus finding evidence that the global circuit contribution is dominated by a superposition of effects from three major zones of convection: tropical South America, Africa and the Maritime Continent (Southeast of Asia and Australia). More recent observations [4] of the ionosphere's potential and NASA satellite observations support this idea [5].

Although past evidences [6], [7] suggest that tropical regions present a semiannual cycle with maximum lightning activity occurring during spring and autumn in both hemispheres, it has been found [8] that the cycle of lightning activity in Colombia (tropical land) depends on several factors but mainly upon the atmospheric circulation effects. Electrical atmospheric activity varies from region to region (spatial aspect) as well as from month to month (temporal aspect).

Although tropical South America, Central Africa and the Maritime Continent areas were identified at the beginning of the 20th century as having high atmospheric electrical activity, the information available in the world on the characteristics and magnitudes of lightning was based mostly on studies carried out in semitropical or temperate zones, but scarce in Tropical Zones.

This research work is very important to continue to statistically verify the variation of the lightning parameters such as the Keraunic level, the ground flash density, the lightning peak current etc., in the tropical zone, with respect to the temperate zone as in the USA., Europe or Asia. These results are fundamental for the design of protection against lightning and its statistical variation makes that the standards of temperate latitudes of protection again lightning, such as IEC62305, IEEE1410, EN50536 and others must take into account this spatial variation and thus mitigate the high mortality by lightning [46], [47] or the high failure of electrical and electronic equipment [45] that occurs in the tropical zone [11].

II. Fundamental Aspects of Lightning Parameters

a) Lightning Peak Current (LPC)

In order to estimate the Lightning Peak Current in tropical zones, Torres et. al. (1996) [8] estimated the return stroke of LPC from 167 electric field measurements performed with a parallel-plates antenna and Lightning Location Systems installed in Colombia. The results show preliminary evidence that LPC higher than in other latitudes could be expected for a tropical zone such as Colombia.

Visacro et. al. [9] and Wilks [10] found that the lightning peak current mean values (40 and 45 kA for the first stroke and 16 kA for subsequent strokes) are higher than other reported values.

The knowledge of spatial behavior of lightning parameters is significant for the design, maintenance and operation of power systems and in the performance of warning techniques. It is essential to strengthen this research line in order to learn the differences between magnitude of lightning parameters measured in north, south and tropical latitudes as well as the differences between plain, mountain or coast zones, and the daily, seasonal and multiannual variations, in order to update lightning parameters for protection of electric power systems with worldwide

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validity. Figure 1 shows a comparison of cumulative probability of Lightning Peak Current between CIGRE (International Council on Large Electric Systems for its acronym in French) and four tropical sites (Malaysia, Rhodesia, Brazil and Colombia) [11].

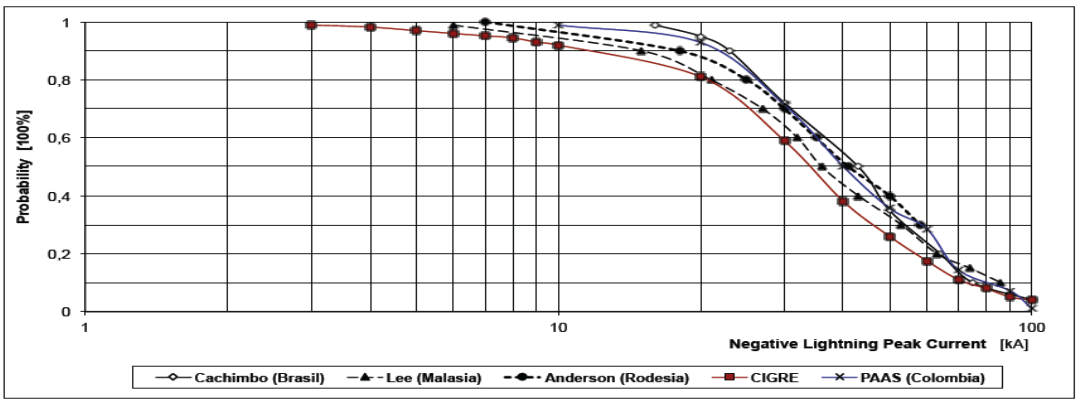

Figure 1: Comparison of cumulative probability of lightning peak current from CIGRE and four tropical sites (Malaysia, Rhodesia, Brazil, and Colombia). Taken from [11]

On the basis of a comparison of lightning current probability distributions obtained around the world, it is possible to state a hypothesis on the latitude dependence of lightning current. Additionally, there are preliminary evidences that higher values can be expected on tropical countries. Recently, Cooray [12] proposed that the experimental data show that the peak currents of first and subsequent lightning return strokes increase with decreasing latitude. The reason for this dependence of current amplitude is explained using the fact that the height of the charge centers increases, as the latitude decreases. The results obtained show that the peak value of first and subsequent return stroke currents is around 42 kA and 15 kA, respectively, in tropical regions. This theoretical prediction is in agreement with available experimental data provided by instrumented 8 towers [13], [14].

The results on the behavior of lightning activity in the tropical regions, compared with the activity in temperate regions are presented by Torres [11], [13], [14]. According to the displacement of the Intertropical Confluence Zone (ITCZ - Global scale) over Colombia (located between 4°S and 13°N Latitude), lightning activity in the southern (Amazons Region) and northern (Caribbean Region) tends to be unimodal (maximum activity in January-February and August-September respectively), whilst in the central Region (Andean mountains) the development tends to be bimodal (maximum activity in April-May and August-September-October). Aka and Ianoz [15] in West Africa presented similar results, where the general trends of lightning activity are similar to the trends in Colombian central region (Andean Mountain), located between similar latitudes.

b) Ground Flash Density (GFD) and Keraunic Level (Td)

The necessity to measure the Ground Flash Density (GFD), as opposed to the Keraunic level (Td), the Td is well known. Nonetheless, the latter is still an accepted parameter used for characterizing certain region of atmospheric electrical activity. Moreover, the gathered time series data of thunderstorm days is very important for statistical analysis when the GFD is not yet measured, which means, it is an unknown parameter.

The traditional equation relating GFD values to Td, GFD = 0,1.Td is only valid in temperate regions. The mentioned equation, developed by Anderson and Eriksson and based on lightning measures obtained from Lightning flash counters located in South Africa, has shown good results when they are compared to Lightning data in temperate zones but not necessarily in tropical regions. This circumstance has motivated research studies of Lightning parameters in Tropical zones, especially in Colombia, Mexico and Brazil, which have collected lightning data from their own Lightning Location Systems.

- GFD vs. Td relationship obtained from Colombian Lightning Location System - LLS data and Anderson's equation were evaluated, finding great errors that show the necessity of developing new adequate equations for Colombian lightning behavior [16]. The errors found in applying that equation in Colombia have reached values up to 1568% [16], [17]. In addition, other Td vs. GFD relationships were found in mountainous tropical regions of Mexico and Brazil as follows [17]:

$$GFD = 0{,}024T_d^{\,1.12} \quad \text{México}$$

$$GFD = 0{,}030.T_d^{\,1,12} \quad \text{Brazil}$$

$$GFD = 0{,}0017.T_d^{\,1,56} \quad \text{Colombia}$$

The similarity between the relations found in Brazil and Mexico may be attributed to the comparable location in terms of latitude (Mexico [16–280 North] and Minas Gerais, Brazil [18-220 South]). However, the

relation found in Colombia (2-100 North), which is located closer to the equator, presents a different behavior.

Moreover, a different behavior of Lightning parameters in tropical zones has been observed for both mountainous and coastal regions, therefore, different equations have been obtained for each type of region [18].

III. Tropical Network of Remote Sensors (TRONSE)

To continue the research work on the spatial variation of the lightning parameters, we have developed a Tropical Network of Remote Sensors (TRONSE) and software, in some countries of the tropical zones. Additionally, the ASIM (Atmosphere Space Interaction Monitor) project has been integrated into the network.

TRONSE is composed by total lightning detection systems - TLDS, electrostatic field sensors and technology tools for Big Data management and Data Analytics applications. TRONSE is a network that began to be built in 2011 with the Colombian network, with coverage of neighboring countries such as Panama and part of Venezuela. Subsequently, new networks have been installed in other countries of the tropical zones. The coverage area is surrounded to the east and north by large coastal areas in the Pacific Ocean and Caribbean Sea; to the west by the largest jungle in the world, the Amazon; separated from each other by the Andes mountain range, with very high peaks, extensive plateaus and large branches that give rise to very complex and unique conditions, enhanced by the continuous influence of the ITCZ.

The main contribution of TRONSE to the spatial study of the lightning parameters has been the installation of more than 43 antennas of location of lightnings in Mexico, Colombia and Peru, which will have more and better information of the lightning parameters (Keraunic levels, Ground Flash Density, Polarity, Lightning Peak Current etc.) in tropical zone and, in the future, to compare these results statistically with data from other similar networks located in temperate latitudes such as the USA, Europe and Asia.

a) ASIM (Atmosphere Space Interaction Monitor) project

Complementary to lightning detection systems, the research group PAAS-UN is working together with European researchers on the ASIM project.

The terrestrial origin of intense bursts of Gamma radiation discovered in the atmosphere (TGFs) is one of the mysteries of the investigations on the physics of lightning that remain unresolved.

Since the discovery of the emission of gamma rays in the Earth's atmosphere, there have been observations that relate the appearance of these emissions with the presence of lightnings. The mission of the ASIM project is to clarify this point.

The TGF´s are much more common than expected phenomena that occur throughout the earth's surface. They are associated with storm zones with electric shocks. They occur between the cloud layer and the ionosphere. Their morphology and dynamics is much more complex than expected. Its distribution in length indicates that they are more frequent on the continents, in tropical zones as Colombia.

The ASIM project has benefited from the cooperation with the National University of Colombia (Research Group PAAS-UN) to establish a network of optical systems to monitor the TLE activity of this region. The University has several available sites covering continental areas such as Santa Marta and the Caribbean (San Andrés Island). The firm Keraunos has networks of electric field mills (PreThor) and data of the Colombian Total Lightning Detection System – CTLDS.

The European Space Agency (ESA for its acronym in English) received in Valencia, Spain, and the ASIM observatory. It's a lightning, ultraviolet; X-ray and Gamma rays observatory that will help understand the global electrical circuit and was installed in the Columbus module on the International Space Station (ISS for its acronym in English). Its launch took place on April 2, 2018 in Cape Canaveral, Florida using a Falcon-9 SpaceX rocket. Once attached the observatory to the Columbus module, its mission is to measure the phenomena above the great storms and its high-energy detector will allow obtaining new data on the violent outbursts of terrestrial gamma rays.

The support given by Colombia to the ASIM project through the research group PAAS-UN, has been the installation around the city of Santa Marta, Colombia, of an observatory of terrestrial antennas known as Lightning Mapping Array (LMA), which is a three-dimensional system for locating total lightnings and information from the network of atmospheric thunderstorm data CTLDS owned by the firm Keraunos. The data analysis of LMA observatory in Santa Marta and a doctoral thesis currently developed by a student at the Polytechnic University of Barcelona, have been fundamental in the understanding of the phenomenon of the terrestrial lightning, that have been basis of work in European universities of the ASIM project (Catalonia, Valencia, Denmark, Norway, Poland) for the understanding of the terrestrial phenomenon of lightning that is now expected to develop from the ISS.

In 2015, seven antennas were mounted around the city of Santa Marta, Colombia, from where the lightning activity between clouds and ionosphere is captured. Now, these antennas have been moved to the city of Barranca, Colombia, since it has been established that the Catatumbo area - including the area of Venezuela- presents the highest lightning activity in the world [44].

With the support of an oil company, the assembly of the antennas in the city of Barranca began, thus creating one of the Largest lightning measurement centers in the world with equipment developed in Colombia (PreThor), CTLDS monitoring system owned by the Colombian firm Keraunos and the information that will be sent from the NASA International Space Station, to follow the steps to the luminous elves; that could give additional lights, about global warming.

b) Total Lightning Detection System TLDS

Total Lightning Detection Networks TLDS are commonly linked to thunderstorm monitoring systems Class II in accordance with standards EN50536 and IEC62793, which are defined as: "detection of IC and CG lightning discharges (phases 2 to 4)" [19], [20]. TLDS have been deployed in the last years along some Latin-American countries; Aranguren et al. [21], [22] described total lightning detection networks in Colombia and other countries; this group is currently known as the Colombian Total Lightning Detection System – CTLDS and is based on the VLF/LF technology widely known as LINET. The LINET technology was introduced in 2004 by Betz et al [23] with a detection technique based on a modified Time of Arrival – TOA - method, adapted to identify and locate intra-cloud strokes, with a 3D functionality. The performance of LLS based on the LINET technology has been widely studied in different researches throughout the world, whose results have been published in papers and technical reports by research centers and meteorological services [23-25].

The CTLDS, widely used in several applications of early thunderstorm detection and lightning localization, currently covers about 90% of the country's continental territory, where more than 99% of the population is covered with a theoretical Detection Efficiency higher than or equal to 90%, as discussed in [21], [22]. The current Total Lightning Detection System - TLDS, was initiated in Colombia as the CTLDS and then extended to neighboring countries, recently Peru, and is described in Figure 3. The sensor base line throughout the network varies from 157 to 360 km, with an intermediate gap in the Amazon area. The TLDS is operative throughout a region dominated by two main conditions: tropical location and the Andes mountain range with very high peaks. A theoretical calculation of the CG Stroke Detection Efficiency – SDE was performed based on the detection efficiency simulations given in [26], Appendix A, and a reference current distribution peak was taken, according [26], section 5.2; it is given in Figure 3. Previous analyses of Detection Efficiency for the CTLDS were published in [21], [22], [27], [28]. High detection efficiency is expected in central areas with high number of surrounding sensors; nonetheless, most of the areas present very high mountains, deep valleys and complex orography in general, where the TLDS performance statistics are not accurately known. Figure 2 gives the altitude of the sensor sites described in Figure 3; note that most of the sensors in Colombia are installed at low altitude, with an average altitude of 701 m.s.l and a maximum of 2702 m.s.l; in contrast, sensors located in Peru have an average of 2123 m.s.l, with a maximum of 4337 m.s.l.

Aranguren et al. [27] and González [28] studied the detection efficiency and location accuracy based on real lightning strikes on power transmission towers along mountainous and flat regions in central Colombia, considering two different power transmission systems and periods of time. The lightning-strike reference towers (direct or very close lightning strikes on shielding wires) were those that showed insulation damages due to flashovers. The accurate time reference was provided by the power protection devices. In summary, 97% (64 out 66) outages caused by lightning strikes correctly matched, in time and position, to the TLDS detections of very close CG flashes, that is, at distances shorter than a few hundred meters. Further works of relative lightning detection efficiency at high altitudes as well as studies based on lightning ground truth events from video reference are currently under development.

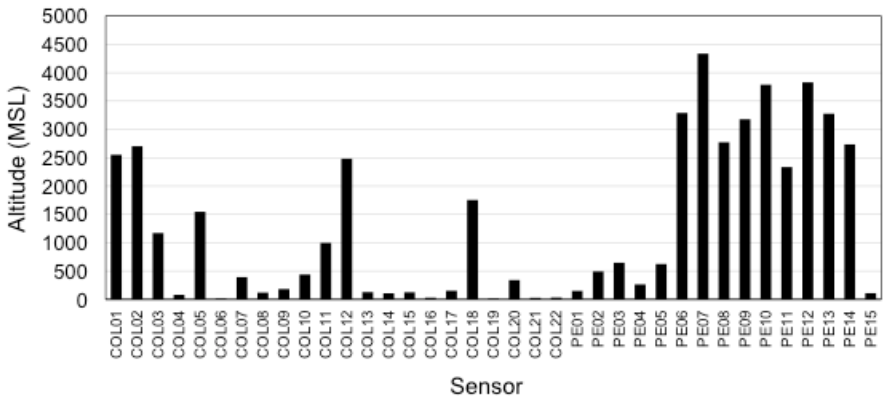

Figure 2: Altitude of the sensor sites that conform the described TLDS.

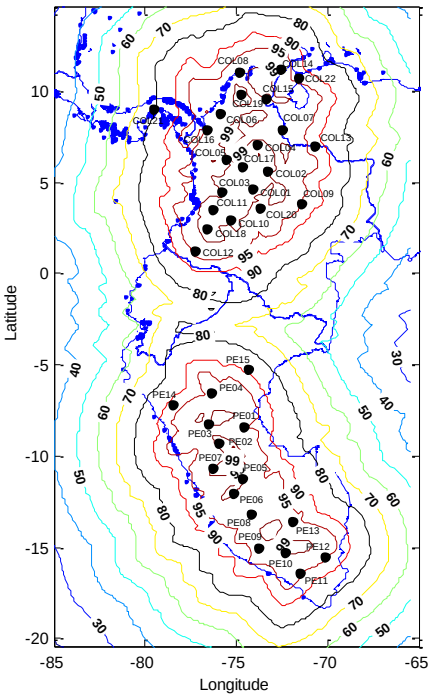

Figure 3: Total lightning detection network and its detection efficiency in Tropical countries.

c) *Electrostatic field monitoring*

The Field Strength Meter – FSM (electric field mill type), registered in Colombia as PreThor, corresponds to the measurement principle classified as thunderstorm monitoring systems Class I according to standards EN50536 and IEC62793, which is defined as: "detection of the thunderstorm over its entire lifecycle (phases 1 to 4)" [19], [20]. As it is well known, in fair weather conditions the environmental electric field is approximately 100 V/m. Storm clouds are characterized by generating electric field variations reaching levels of up to 15 kV/m in flat areas. As the storm cloud approaches the measurement point, changes in the electric field amplitude and polarity (usually, from positive to negative), are observed. These two effects are commonly used as criteria to timely detect the lightning risk within a region of interest, through the activation of an early alarm. This area is defined within the measurement range of the electric field sensor, which can reach up to 20 km (30 km or longer in mountainous areas). Figure 4 illustrates the typical behavior of the electric field signal (given in blue) recorded when a storm cloud approaches the measurement site. The red dots indicate the lightning strike distance to the sensor site. In this case the lightning activity approaches to the measurement point from a distance of approximately 60 km. As it gets closer, there are changes in the electric field magnitude, where, the greater the instantaneous variation ΔE, the greater the electric charge transferred by the flash or the closer the discharge to the measurement point occurs.

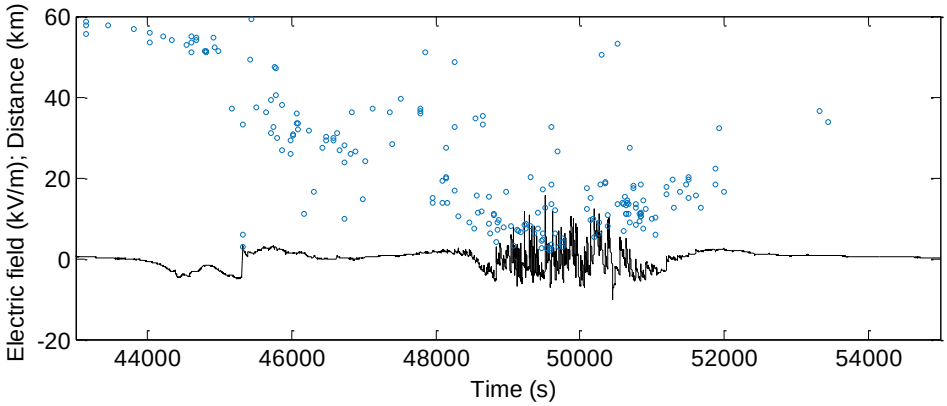

Figure 4: Measure of the electric field (black line) versus flash distances (blue dots) recorded by an electric field mill station in Bogotá (2600 m.s.l) during a thunderstorm event on November 17, 2010 [29]

In spite of the electric field measurement being recognized as the most direct way to monitor the thunderstorm electrical evolution, it involves a lot of uncertainty and ambiguity in relation to its calibration. The electrostatic structures of thunderclouds have been deeply studied typically under almost ideal measurement conditions, as published by Jacobson et al [30], Koshak et al [31], Krider et al. [32], and many others, by using a high number of electric field sensors on flat terrain, short baselines, and installed under quite controlled locations, free of neighboring elements which could influence on the site error. An important amount of electrostatic field sensors has been deployed throughout the area described in Figure 2, during the last years. Most of them intended to setup thunderstorm warning systems and some of them installed to conform experimental networks for scientific purposes. However, the measurement conditions are far from ideal; records of electric field measurements are available from electrostatics field sensors installed up to 4550 MSL (Cusco, Peru), on very irregular terrain and affected by several additional local factors. The performance of electrostatic field sensors under last complex conditions has been poorly studied.

Specifically, Aranguren et al. [29], Lopez [33] and Lopez et al. [34] have investigated the measurement patterns under real complex orographic conditions within the tropical area given in Figure 2. Orographic effects and pattern profiles of the electric field changes ΔE versus the lightning striking distance for last no-ideal conditions were investigated by Aranguren et al [29] who carried out a comparative analysis using atmospheric electric field records during thunderstorm seasons in sort of locations and situations. Thunderstorm electric field patterns at the ground level were studied by using modified electric field sensors [29], [35] installed in Bogotá - Colombia, in 2010; conventional electric field mills in mountainous areas of Navarra - Spain, in 2009 and electric field records provided by the Advanced Ground Based Field Mill (AGBFM) Network in Kennedy Space Center (KSC), Florida, USA, during 2009.

Absolute reference patterns are not possible regarding the atmospheric electrostatic field. However electrostatic field records in Florida (electric field changes ΔE versus cloud-to-ground flash strike distances) represent one of the best reference distributions, useful even for tropical regions, as developed by Aranguren [29]. Figures 5 and 6 show the electric field changes ΔE measured in San Martín – Colombia, at 130 m.s.l; and Cusco – Peru, at 4,550 MSL; as a function of the cloud-to-ground flash distance. The sensor type, installation characteristics and calibration factors are practically the same in both cases. Maximum electric field changes ΔE for very close CG flashes in the lowland case are in general lower than 10 kV/m; on the contrary, at high elevation as in the second case, the nearby flashes cause maximum electric field changes around 30 kV/m or even higher.

Figure 7 allows comparing the behavior of the mean magnitude of the electric field change ΔE measured by electrostatic field sensors installed in Bogotá - Colombia, at 2,600 MSL and at a north latitude of 4.64°; together with Cusco –Peru, at 4,550 m.s.l and at a south latitude of 14.47° and the reference curve obtained from the Advanced Ground Based Field Mill (AGBFM) Network – AGBFM in Florida, at 0 m.s.l and at a north latitude of 28.50° (discussed in [29]). All electric field changes ΔE, as those shown in Figures 5 and 6, were used to obtain the mean ΔE values at each distance and to adjust a point charge model, as explained in Aranguren [50]. Mean magnitudes of sudden electric field changes for CG flashes at long distances, that is to say longer than 10 km, are practically the same in all cases; however, for short distances the mean magnitudes vary considerably. For very short distances, around 0 km, the mean magnitude of the electric field change is close to 3.5 V/m in the first case (elevation of 130 MSL) and around 9.7 kV/m in the second one (elevation of 4,550 m.s.l).

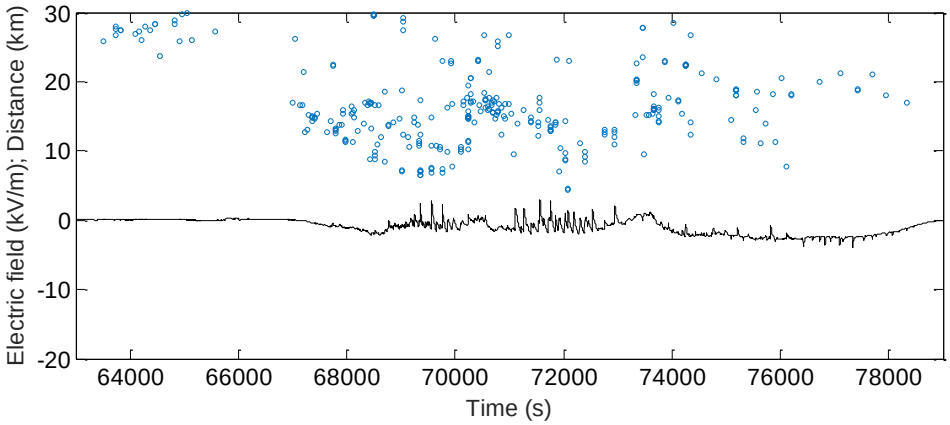

Figure 5: Electric field recorded (black line) versus flash distances (blue dots) recorded in San Martín - Colombia (130 m.s.l), during a thunderstorm event on July 23, 2018.

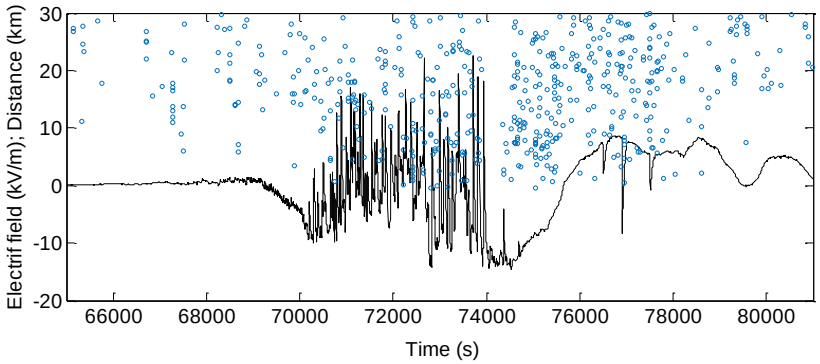

Figure 6: Electric field (black line) versus flash distances (blue dots) recorded in Cusco – Peru (4550 MSL), during a thunderstorm event on November 15, 2017.

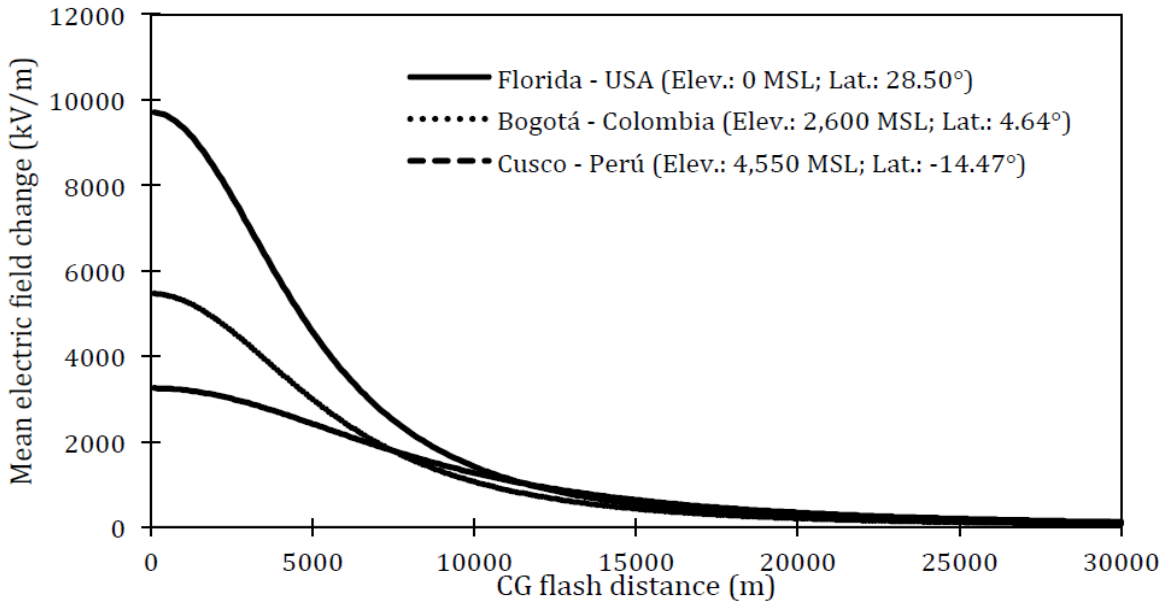

Figure 7: Profiles of the electric field change ΔE for different electrostatic field sensors in Bogotá, Cusco and Florida. Field sensors in remarkably different altitudes.

Last magnitudes result logical and expected given the fact that the relative altitude of the cloud charges respect to the sensor position becomes lower as the terrain elevation is higher. As an additional influencing factor, the vertical growth of thunderclouds in the tropics is expected to be greater due to the higher tropopause altitude. Recent papers by Lopez et al. [36], [37] have studied the altitude of electric charge centers in tropical thunderclouds by using a LMA (Lightning Mapping Array) in Colombia and have found that the majority of leader flashes are initiated at altitudes between 10 and 11 km, and that this altitude is in average 2 km higher than similar thunderstorms in Europe, studied by using a similar LMA system, at a north latitude around 41° where most of the flashes are initiated at around 8 km. References of similar analyses in Florida by using LDAR-II (Lightning Detection and Ranging) [38] show that charge altitudes in Florida thunderstorms do not present a wide difference with respect to the observations at the tropics.

The 3D total lightning detection system supported on LINET methods also provides valuable information regarding the charge altitudes. Aranguren et al. [14] reported the frequency distribution of the IC stroke heights obtained in central Colombia and found a median height of 10.2 km. Hoeller et al. [24] published the IC emission height frequency for Brazil, Benin and Australia; in all three cases the median heights vary from 10 to 11 km. Figure 8 describes the relative frequency of IC emission heights in Colombia and Peru obtained from the TLDS described in Figure 2. The median emission heights (and standard deviations) in Colombia and Peru are 10.2 km (3.09 km) and 10.8 km (3.18 km) respectively. No significant differences are observed between the two distributions. The reported heights are a little higher in the dataset from Peru than in Colombia's, but that difference could be explained by a systematic error associated to the terrain elevation at the sensor sites which causes that important corrections be applied for the IC height calculation in the lightning location algorithm.

Having explained the above, the behavior of the electrostatic field changes ΔE in the high mountain conditions of the Andean and tropical regions is mainly affected by the relative low altitude of the cloud charge centers. Additional special situations result when the measurement point is located on the top of a hill or inside a valley; in the first case the cloud electric field can be measured at longer distances, that is, up to 30 km or longer; in contrast to the second one where the measurement range is reduced. Therefore, each electric field sensor used under the Andean and tropical conditions described along this paper has its own measurement characteristic. Such unique characteristics of each place influence the performance of the sensor network applications, such as the early warning systems.

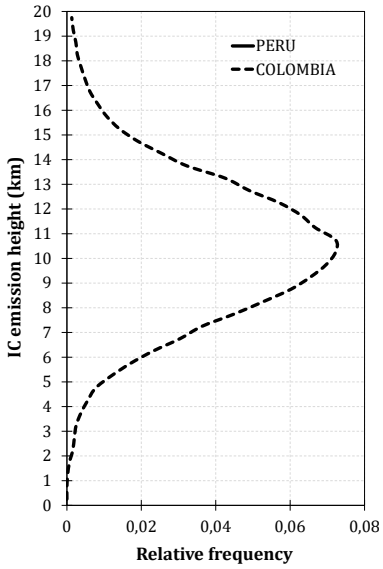

Figure 8: Relative frequency of the IC emission height given by the total lightning detection systems in Colombia and Peru.

IV. Thunderstorm Early Warning Systems

(Guidelines or hints for any reader if they're interesting to learn anything from this work.)

The TRONSE system is envisioned as an integrated information network where all data is indistinctively used to study and develop high effective lightning early warning systems, among many other applications. The warning criteria definition and verification are based on the reprocessing of all available historical data in the area of interest. For example, the available large datasets of total lightning are used to analyze an initial simple circular area scheme composed by the Monitoring Area – MA (geographic area used to provide a valid warning for the target area) and the Surrounding Area – SA (geographic area in which a Lightning Related Event – LRE causes a potential danger); the common used warning verification statistics such as False Alarm Ratio – FAR (ratio of false alarms to the total number of alarms) and Probability Of Detection – POD (ratio of effective alarm with respect to the total number of situations with LRE in the SA), among others, are evaluated. Simple sensitivity analyses allow understanding how FAR, POD and others vary when the settings are moved and static early warning systems are then tuned; however, current Machine Learning tools allow developing dynamic early warning systems.

Table 1 describes some of the lightning warning verification studies carried out in the TRONSE area by using CG lightning detection, total (CG+IC) lightning detection and electric field measurement – EFM under different situations. Each study was performed to find the best criterion to maximize POD and minimize FAR (warning area sizes and shapes, as well as, BIAS and Critical Success Index - CSI were also evaluated in some references, but not given here). CG lightning detection on simple area schemes was initially studied in Colombia using a data series of CG flashes from 1997 to 2001 [39]. Lightning data in that case was provided by the lightning location system described in [25] whose flash detection efficiency was estimated around 60% to 80%. Poor POD and FAR was found for early warning systems on the Colombian mountain ranges. Lightning warnings derived from electric field sensors at high altitude (Bogotá, 2600 MSL) were performed by Aranguren [29] by using a simple threshold criterion; POD of 0.92 and FAR of 0.6 were obtained. Very similar results were obtained some years later when the electrostatic field measurement was evaluated at very high altitude (Cusco, 4550 m.s.l) with POD of 1 and FAR of 0.56 [40]. The First warning verifications based on EFM under complex mountainous conditions (deep valley: Valle de Aburrá (1490 m.s.l) was conducted by Lopez et al. [33], [34]; the best performance obtained showed POD of 0.68 and FAR of 0.46 when exhaustive warning criteria beyond the simple electric field threshold was tested. Total lightning detection was introduced by Aranguren et al. [41] and Inampués [42] in combination with an EFM network along a large area in the Colombian Eastern Plains; POD of 0.96 and FAR of 0.45 were obtained. High or very high POD has been apparently easy to obtain in mountainous areas when EFM are supporting the lightning warning systems; on the contrary, the FAR has resulted in a difficult optimization subject. The most recent studies, such as the one performed by Chávez et al. [43] in 2018, took into account a comprehensive and iterative search of lightning warning criteria based on both EFM and total lightning detection. A combined criterion of CG and IC stroke rates and electric field vs time patterns allow obtaining a significantly improved FAR of 0.22.

Table 1: Studies about lightning warning verifications in the TRONSE area

Location and year	Data and criteria	POD	FAR
Entire Colombian territory; Inampués et al 2009 [39]	CG lightning detection within a simple area scheme.	Lowland: 0.6 to 0.9 Mountain: 0.3 to 0.7	Lowland: 0.6 to 0.8 Mountain: 0.7 to 0.9
Bogotá – Colombia; high altitude; Aranguren 2011 [29]	EFM	0.92	0.6
Medellin – Colombia; Mountainous area; Lopez 2011 [33] and Lopez et al 2012 [34]	CG lightning detection and EFM; conventional method and exhaustive EFM criteria.	Conventional: 0.64 Exhaustive: 0.68	Conventional: 0.69 Exhaustive: 0.46
Colombian Eastern Plains; Aranguren et al. 2013 [41] and Inampués 2014 [42]	Total lightning detection (CG+IC) and EFM; exhaustive criteria.	0.96	0.45
Cusco – Peru; very high altitude. Chávez et al. 2018 [40]	EFM.	1.0	0.56
Magdalena River Valley – Colombia. Chávez et al. 2018 [43]	Total lightning detection (CG+IC) and EFM.	0.92	0.22

V. Discussion

Several research results have shown the influence of latitude in the lightning phenomena and how the magnitude of lightning parameters is not necessarily valid in different geographical zones all over the world. Some measurements suggest that those are different in tropical latitudes than in temperate ones. It is essential to enhance this research in order to learn the differences between magnitude of lightning parameters measured in north, south and tropical latitudes as well as the differences between plain, mountain or coastal zones, and the daily, seasonal and multiannual variations, in order to upgrade the parameters for lightning protection. Taking into account the above, the main contribution of the TRONSE system is to provide new information in large quantities about the lightning phenomena under very special conditions of tropical weather, large coastal and great mountain ranges. However, the physical models used to interpret the measurements must themselves be revalidated. Both, the evaluation of lightning detection efficiency and the calibration of the electrostatic field measurement are based on reference physical parameters obtained from accepted reference measurement systems; such reference parameters are for example the peak current distribution in the case of CG lightning detection, or cloud charge models in the case of the electric field. Such reference distributions are very poor, practically not available, in tropical areas and even less available under high mountain conditions. This paper discussed about some of those references physical parameters. On the other hand, the use of thunderstorm warning systems has increased in recent years in the tropical regions, with a growing demand in terms of optimal performance; such purpose intrinsically involves the use of advanced techniques of Big Data management and data analytics as it was partially discussed here. (Expand the discussion on Big Data technologies)

VI. Conclusions

The deployment of a remote sensing network for lightning monitoring throughout the countries of the tropical zones was presented. Particular characteristics of this region are denoted by the influence of large coastal areas, the largest jungle in the world, the Amazon, a very high and complex mountainous system, the Andes, and the influence of the Intertropical Convergence Zone. Total lightning detection and electrostatic field measurement conform the TRONSE system with sensors located at altitudes from the sea level to more than 4.500 MSL. The primary purpose of the TRONSE system is to contribute to the systematic study of the occurrence and amplitude parameters of lightning in the Tropics, but also, in the study of the operative principles, models and performance of lightning monitoring systems in such conditions. Total lightning data and LMA information provided coherent data about the altitudes associated to the IC stroke emission and the cloud main charges (10 to 11 km). In addition, electrostatic field measurements at altitudes from the sea level to 4550 m.s.l showed how the vertical cloud structure influences the behavior of the electrostatic field at high mountains, where the main factor is the relative lower altitude of the charge centers.

A cumulative experience about the use of total lightning data and electrostatic field measurements in thunderstorm warning systems under tropical and Andean mountain conditions was presented. Performance statistics for lightning warning verification showed that the commonly used warning parameters (CG lightning detection on simple warning areas, or, EFM thresholds) do not produce very reliable or effective systems, in some sort of typical situations.

Having explained the above, the behavior of the electrostatic field changes ΔE in the high mountain conditions of the Andean and tropical regions is mainly affected by the relative low altitude of the cloud charge centers. Additional special situations result when the

measurement point is located on the top of a hill or inside a valley; in the first case the cloud electric field can be measured at longer distances, that is, up to 30 km or longer; in contrast to the second one where the measurement range is reduced. Therefore, each electric field sensor used under the Andean and tropical conditions described along this paper has its own measurement characteristics. Such unique characteristics of each place influence the performance of the sensor network applications, such as the early warning systems.

Several research results have shown the influence of latitude in the lightning phenomena and how the magnitude of lightning parameters is not necessarily valid in geographical zones all over the world. They are different in tropical latitudes to those in temperate ones. And it has effects in mortality rate by lightning and in the design of power systems.

The systematic study of Holle [46] reveals, for example, that in the USA the mortality rate from lightning was 0.2 deaths per million inhabitants in the period 2000-2006. In Australia the mortality is 0.1 deaths per million inhabitants in the period from 1980s to 1989. In France were 0.2 deaths per million inhabitants in the period from 1990 to 1995. In Japan was a little over zero fatalities per million inhabitants in the period from 1990-1997. In contrast, the mortality rate for all Colombia, a typical tropical country, was 2.0 per million inhabitants per year over the period 2000-2017, [27], [28].

Funding

For more than three decades, this research work received financial funds from public and private companies, mainly from the Department of Science and Technology of Colombia COLCIENCIAS and the National University of Colombia.

Acknowledgments

The authors are grateful for the support provided by the Research Program of Acquisition and Analysis of Signals of the National University of Colombia PAAS-UN in each experimental work that in part helped acquire the information that allowed the development of this research. To the Colombian oil company ECOPETROL for its support in the areas of measurement and to the Industrial University of Santander for its academic support. The authors thank the firm Keraunos for its support with lightning data.

Conflicts of Interest

The authors declare no conflict of interest.

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Global Journal of Science Frontier Research: a
Physics and Space Science
Volume 20 Issue 1 Version 1.0 Year 2020
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

The Cosmic Dark Matter Fractal Field Theory Reveals an Explanation for Quantum Healing by Plank Flowmotion of Morphogenetic Fields Enhanced through Heart-Brain Coherence Meditation Techniques

By Timothy Fulton Johns DDS

Abstract- The process of biologic Morphogenesis of all life forms as well as some inorganic structures has been studied and examined by many in science. Each investigation arriving at descriptions of the wonder and beauty of nature's art work and evolutionary resilience but without description of the process of the ability of natural blueprints' to repeat form and function or how evolution modifies those blueprints' to accommodate environmental changes to increase survival success of many life forms. The method by which nature reproduces with such repetitive and reparative accuracy of the form and function of a vast variety of organisms known to exist, as well as, certain inorganic forms such as crystals and other well-known shapes of occupied space has eluded science. There is now, however, an emerging theory that reveals a natural process which explains this mystery of nature!

GJSFR-A Classification: *FOR Code: 020106*

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I. Introduction

THe Cosmic Dark Matter Fractal Field Theory (CDMFFT) predicts that there is a database of archetype information stored in the Dark Matter/ Dark Energy zone of our Cosmos. (*1) This unexplored part of our reality represents the unseen 96% of our visible universe conceivably not only responsible for the underlying form but possibly acting as a repository of stored information involved in evolutionary influence of form and function within many types of morphogenetic and bio-cognitive fields. This previously unrecognized and unseen process could explain many mysterious enigmas in our study of the biosphere on our planet as well as others, such as total regeneration of severed anatomical parts of certain life forms. This could also explain spontaneous healing of otherwise fatal pathology in our own and other species of the animal kingdom, even the long search for how a human or other fertilized cell knows its blueprint of form and function that takes it from a zygote, to a blastula and finally to a developing living embryo of species specific form and function! It is even conceivable that water known to be essential for life as we know it is working as a biologic antenna responsible for receiving the signals of life from the DM/DE zone to start or trigger initial forms and function of life forms even ongoing daily cellular regeneration of healthy cell replication. (*2)

The Cosmic Dark Matter Fractal Field Theory (CDMFFT) as presented in the book "The Great Cosmic Sea of Reality," provides an explanation.

Our reality is indeed illusory when taken into full context as a part of an expanse that sits almost exactly in the middle of a scalar continuum from the Planck scale at 10^{-35} meters to the vast visible universe 10^{35} meters and the super-massive objects at this scale known to exist there. Even more illusory when we consider that all of the matter that we can perceive through scientific inspection and even our individual sensory perceptions make up only 4.6% of our entire cosmos. The presence of dark matter and dark energy accounting for the other 95.4% leaves quite a void in our pretense to understand the cosmos. However, there are significant clues that lead to clarity when the body of scientific research is considered across multiple disciplines. Most notably is the conclusions of the WMAP project of NASA, https://map.gsfc.nasa.gov/news/

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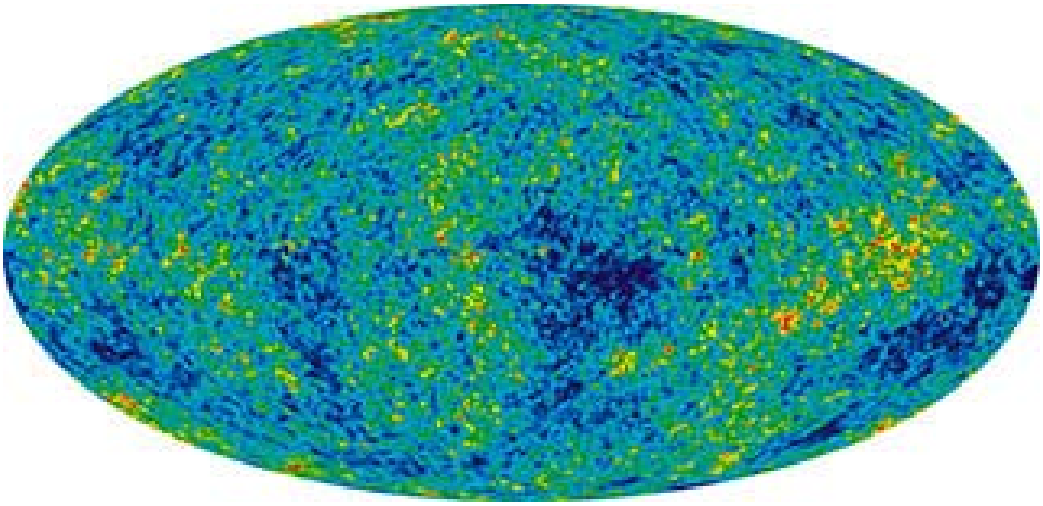

Fig. 1

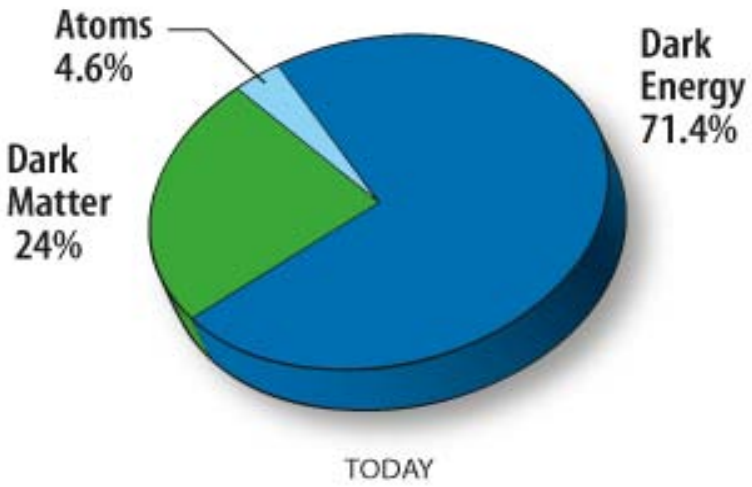

Fig. 2

The WMAP science team has determined, to a high degree of accuracy and precision, not only the age of the universe, but also the density of atoms; the density of all other non-atomic matter; the epoch when the first stars started to shine; the "lumpiness" of the universe, and how that "lumpiness" depends on scale size. In short, when used alone (with no other measurements), WMAP observations have improved knowledge of these six numbers by a *total factor of 68,000*, thereby converting cosmology from a field of wild speculation to a precision science.

The universe comprises only 4.6% atoms. A much greater fraction, 24% of the universe, is a different kind of matter that has gravity but does not emit any light --- called "dark matter". The biggest fraction of the current composition of the universe, 71.4%, is a source of anti-gravity (sometimes called "dark energy") that is driving an acceleration of the expansion of the universe.

WMAP has also provided the timing of epoch when the first stars began to shine, when the universe was about 400 million years old. The upcoming James Webb Space Telescope is specifically designed to study that period that has added its signature to the WMAP observations.

This Great Cosmic Sea I speak of in my book is part of our environment and what I believe cosmologist now call dark matter/dark energy (DM/DE). Said another way, dark matter/dark energy represents the other 95.6% of your reality in the very room where you sit. It is what early investigators called another name the vacuum space, ground state or zero point field. My preference, a more descriptive name, is the cosmic dark matter fractal field (CDMFF). This is an all pervasive field that surrounds you, in total and in part, at every cell interface and beyond. Another way to look at this fact of our reality is that we only can know and actively study 4.6% of our Universe under current theories. Therefore, keep an open mind to this new explanation of our working Cosmos. This Cosmic Dark Matter Fractal Field interacts with your personal morphogenetic field which has a literal universe of nested fractal fields that work in resonate harmony and interact with “the total you” and

that is including your Microbiome. The real you— or the whole you— is actually what you think of as "you," plus trillions of microbes within your alimentary tract, on your skin and in a cloud-like field surrounding you. At the 10^{-15} meters scale, in fact, 90 percent of all the cells that constitute you are nonhuman. To go a step further, 99 percent of all the genes that are you are nonhuman according to the Microbiome Project. https://www.worldsciencefestival.com/videos/microbiome-vital-cells-existence/?gclid=Cj0KCQjwrrXtBRCKARIsAMbU6bHJkn_9I9qjTlVDtGMy3pR71YGMpEn_N3Cvd4_UyXwokzLs5Ci7KuIaAuPyEALw_wcB The CDMFF is a part of or actively working with DM/DE creating our reality at every level providing a type of unseen blueprint of substructure needed to direct and form atoms that make up all matter.

It is the prediction of the CDMFF theory that both biocognitive as well as biomorphic field transradition is occurring within Inner Space giving a more complete explanation as to how these well-known observations of accretion in the WMAP observations might actually work. See my paper on Quantum Scalar Gravity and General Relativity (2). There is another possibility to consider here and that is of a reservoir of Jungian type archetypes which exists as a combined collection of life force blueprint archetypes expressed across perhaps millions of planetary biospheres throughout the entire universe. See my paper on "Mind Fields" (1).

It is a prediction of the CDMFFT that Black Holes (BH's) exist at many different scalar levels and act as a focal point of gravity that begins the ubiquitous process of the "drain hole" accretion action in non-occupied space-time. This local scalar action forms the accretion disk that attracts the morphic fields that provide the blueprint detail instructions which attract the virtual particles, that form the needed atoms, which form the required molecules to produce the scalar coherent domains of both animate and inanimate objects. This fractal process occurs throughout The Great Cosmic Sea including occupied space-time in the appropriate way as directed by evolution and archetype influences of morphic fields but first starting in Inner Space well below our scale at zero point 10^{0} meters. The black hole/white hole dynamics provide the hidden engine underlying this process of scalar functional dynamics in this ongoing cyclical process. This energy flow I call Planck Flowmotion is described in the figures seen below! (Fig. 5)

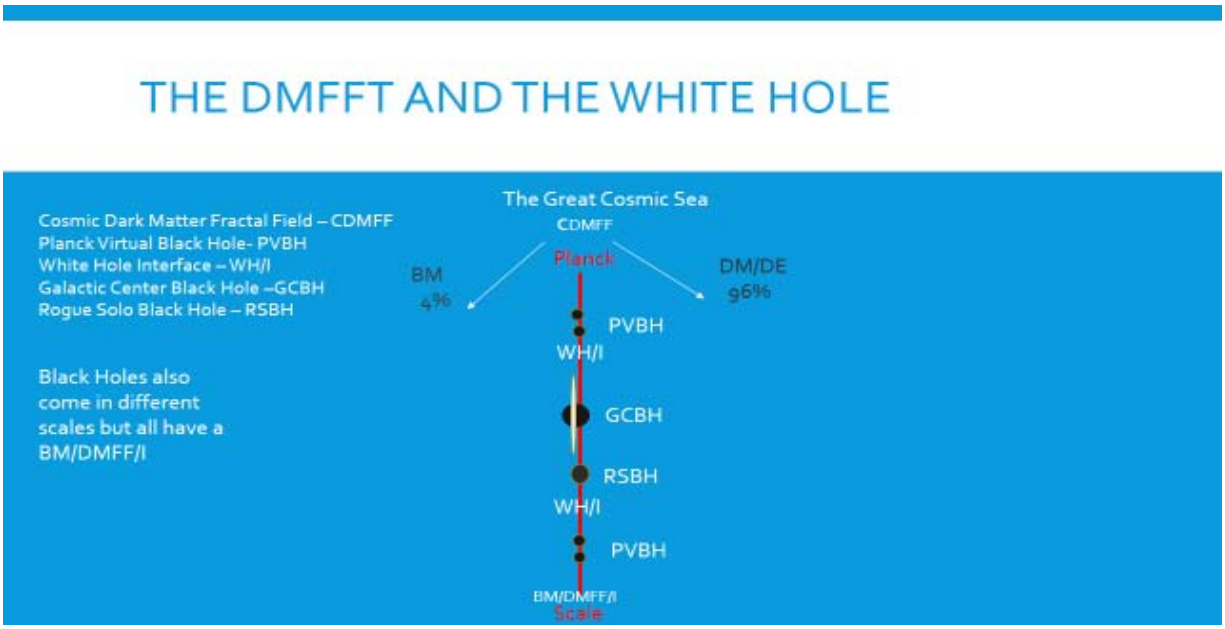

Fig. 3

Fig. 3 is a diagram that depicts the prediction that absolutely everything in occupied space has one thing in common. All share a Planck Zone interface at 10^{-35} meters scale with Baryonic Matter/Dark Matter/Dark Energy represented by the red line. So all Baryonic matter, without regard to scale has this membrane –like zone and exists much like oil mixed with water where much interplay of energy dynamics occur producing reverse Entrophy through Black Hole White Hole dtnamics as explained in another paper found in the resource page at the end (9) the resulting Flowmotion of this high energy zone is depicted in Fig. 5.

This action of these fields are seen in Fig. 4 which was actually captured in an unscheduled experiment on the International Space Station when one of the astronauts placed dry salt in a air filled plastic bag in weightless conditions and observed the natural unaided clumping of the salt crystals as Quantum scalar accretion occurred in front of his eyes and the camera.

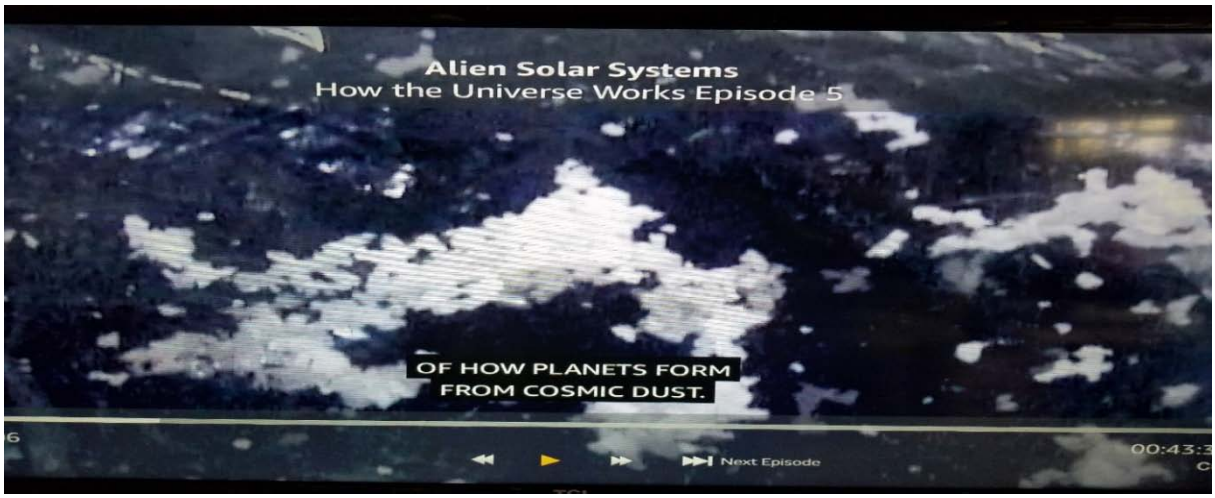

Fig. 4

The interface, at the Planck scale the red line in (Fig 3, 5}, is the point of creation of virtual particles which provide the subatomic particles under certain conditions (see Possible Origins of Virtual Particles https://globaljournals.org/GJSFR_Volume17/1-Possible-Origins-of-Virtual.pdf) the raw material of the atoms that make up our baryonic world, the cusp of creation of baryonic matter (BM), the headwaters of The Great Cosmic Sea. This occurs under the influence of morphic fields and the never-ending inertial motion of our baryonic world related to its density and velocity moving through space-time, at the BM/CDMFF/I the red line in (Fig 3, 5},. That process is what produces what we experience and observe as gravity as stated in Einstein's theory of general relativity and Puthoff's explanation of gravity produced as a drag force created by the acceleration and gravity is an emergent property of this dynamic motion of our cosmos. Of subatomic particles through the Lorentz force, a magnetic field of the CDMFF. (2)

II. Information Transfer to Morphogenetic Fields

However, there is another important creation occurring as this happens, and that is the information-enhanced fabric of space-time; the literal recycling of what was destroyed/changed at the singularity of black holes of all scales, for it too has a BM/CDMFF/I (redline), where the CDMFF prevails and carries information with it in some unknown way and leaving older BM behind while passing its information forward into the CDMFF. There is a process of ongoing cyclical creation and enhanced reformation, therefore, regeneration of cell and organ health in the animal and plant kingdom in our cosmos that begins at the baryonic matter / cosmic dark matter fractal field/ interface directed by the formative causation through morphic resonance working within the CDMFF, producing our baryonic reality at the Planck scale, flowing out of the white hole interface. This cycle is then completed as this baryonic matter makes its way through the flow of space-time to a black hole space-time singularity in the PVBH, at the core of galaxies and other rogue solo black holes dispersed throughout the cosmos. This is where both space-time and baryonic matter, with its information, is engulfed, preserved, and returned to its source in the CDMFF. Therefore, the flow of space-time starts in our baryonic world at the Planck BM/ CDMFF/I and its creation of matter and gravity, which occurs like BM rainfall on a dark matter/dark energy mountain range with many different chreodes or undulations, peaks, valleys and water shed-like directing of the flow and form of BM, determining volume (mass) and direction of the flow all through the process of morphogenetic fields with formative causation influenced by the morphic resonant memory retained within the CDMFF brought from the past to the present.(2,10)

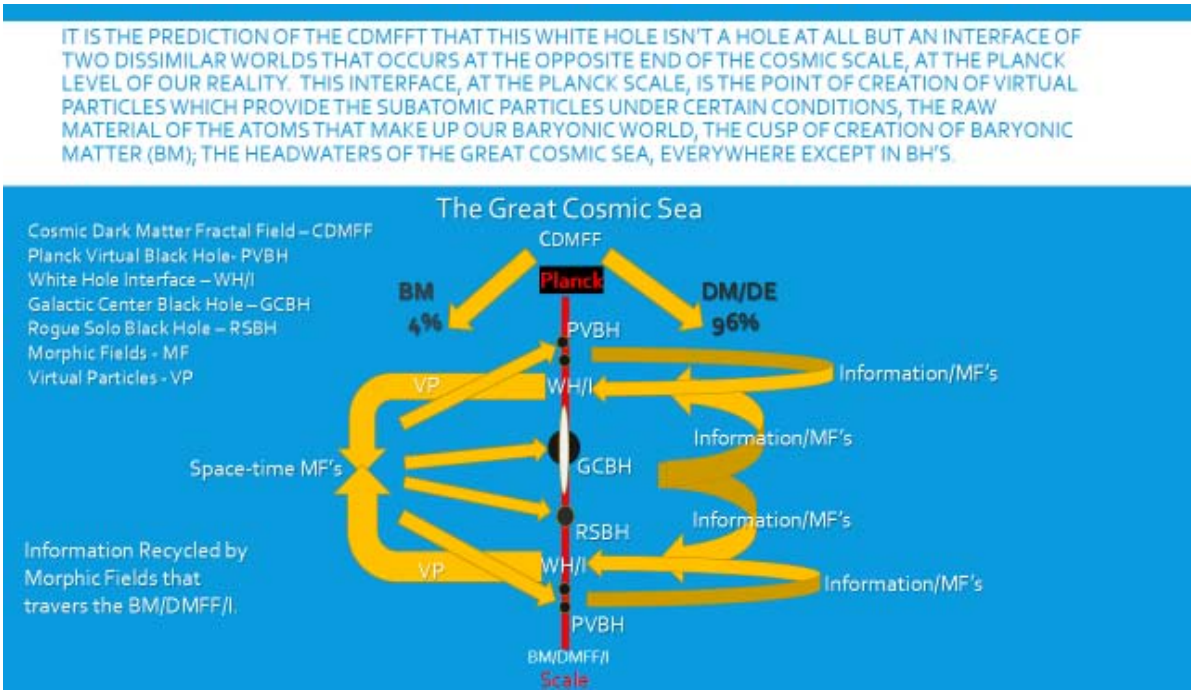

Fig. 5

This influx and reflux of information conserved in the Great Cosmic Sea transmitted through resonant morphic fields and its influence on any organism is quite possibly an amalgamation of input from other similar recursive species from multiple biospheres across the Cosmos and across repetitive cycles throughout the evolution of the Cosmos. Conservation of information by Black Holes has been predicted by physicist John Wheeler and more recent work by physicist Steven Hawking. This possibility, while mind boggling, has reasonable probability; Fractal Fields do fill in the gaps of our scientific imagination nicely.

What could be more unifying than a field theory that explains the creative source and cyclical nature of destruction, recreation and ongoing influence on the particles of matter both animate and inanimate, organic and inorganic, that it is made of at all scales of expression throughout the Cosmos. Rupert Sheldrakes' theory of Formative Causation (FC) by Morphic Resonance (MR) in the context of Cosmic Dark Matter Fractal Field theory implies that there is an intelligence and a unity to this evolution of the Cosmos in favor of directed morphic resonate change in response to not only local environmental variation but non-local cosmic morphic changes in other environments that prove successful in similar and dissimilar worlds throughout the Cosmos.(10) Therefore, morphogenesis is transmitted through Cosmic Dark Matter Fractal Fields, employing Quantum Field's (QFT) as seen in the organizing effects of Quantum Electrodynamics (QED), through resonant Scalar Coherent Domains (SCD) employing holistic symmetry utilizing resonate Local Correlated Symmetry (LCS) throughout all self-similar worlds in the Great Cosmic Sea. It seems quiet plausible the successful evolutionary survival of the species in all worlds through Scalar Resonate Cosmic Morphogenetic Fields might be just one of many repercussions to our reality still out of our awareness.

III. The Science of Healing through Planck Flowmotion and Regenerative Healing Fields at Work

There are pioneers in the use of this emerging healing technology I will introduce and quote elements of their research along with the elements of on-going practice and methods discussed in their research which I have embraced personally along with my wife and have benefited greatly. It is the directives of the CDMFFT that reveal how this new Medical technology is possible and the theory that best explains the known evidence of success verified by the work in particular of Dr. Joe Dispenza. I will attempt to show you quotes from their work and inject the elements of my theory that underpin the clinical findings experienced by those who have had miraculous results from this self-healing technology.

The HeartMath Institute https://www.heartmath.org/about-us/hmi-mission/ is a research group founded since 1991, when Doc Childre founded the nonprofit HeartMath Institute, their vision was and has been to provide tools that connect us with "the heart of who we truly are." Today HeartMath serves people of all walks of life around the world in their homes, classrooms and communities – so they can live healthier, happier and more fulfilling lives. Rollin McCraty Phd, and other key researchers with HeartMath have published impressive

research that reveals scientific evidence of the healing capacity of maximizing coherent Heart Rate Variability as obtained during the use of biofeedback technology that focuses our natural ability to engage a coherence of energy waves between the Heart and Brain. Dr. Joe Dispenza https://drjoedispenza.com has truly taken this Heart-Brain coherents technology to a whole new level by writing several books of his research as practiced for the last 15 years in over 32 countries. The work of these people are vast and will take too long to explain in detail but I will reference their work below.

IV. Signals Sent and Received from Inner Space

So what kind of signals might we expect to be coming from the Planck Zone? Well it is important to remember that all occupied space including you have a Planck Zone. Our health and wellbeing is dependent on several factors but one of the most critical is that every old cell must be replaced with a new one through a cellular process known as mitosis that continues cell presence that carries on the over 100,000 critical cell functions every second! This highly complex and dynamic regenerative life sustaining ubiquitous cellular function is occurring within over fifty trillion cells that make up your body. Each and every one is replaced with a new healthy replicate cell. Our body is extremely dynamic and ever changing due to this high turnover rate of your cells, 90% of which are replaced every 90 days. It is believed that the remaining 10% is replaced every year or so. That is a lot of cell division and duplication and that's when errors can occur producing disease such as cancer cells that are cells that know how to divide and replicate but do not know how to undergo the next step called apoptosis, planned cell death, they just continue to live as seemingly immortal cells and produce an uncontrolled growth that usually kills the organism. So new reliable and accurate duplication of form and function is very important to maintain which requires some kind of removal of sick cells or redundancy to catch and correct errors in duplication of form and function. There are ways in which your immune system catches these renegade cells and takes them out of the body but a new theory of how self-regenerating redundancy may occur has now emerged the CDMFFT; as a result of a larger understanding of how our entire reality may work in resonate health regenerating harmony.

The Cosmic Dark Matter Fractal Field Theory predicts that there are Morphogenetic scalar fields as described in the work of Rupert Sheldrake, and my book "The Great Cosmic Sea of Reality" that retain within them a memory of the prior proper form and function of every cell of every organ in your body that projects a signal that contains these healthy corrective patterns that are followed by these new cells. The new cells move into proper position as directed by this CDMFF blueprint which provides a guiding scaffolding that these cells follow too providing an accurate redundancy pattern to maintain healthy form and function throughout a huge number of repetitive cycles year after year. These fields exist and are stored like a database in the DM/DE zone of our reality on the other side of what is described in the theory as the Baryonic Matter/Cosmic Dark Matter Fractal Field/ Interface(*1). These fields can be attracted to our body by employing Heart-Brain resonate coherence during the meditative methods pioneered by the Heart Math Institute as described in the research of Rollin McCraty, PhD. as well as most recently discussed in the books by Dr Joe Dispenza "Becoming Super Natural" and" You Are the Placebo". Therefore, I urge you to identify and employ the methods that are involved in this form of regenerative health sustaining natural activity and apply this natural healing process as a medical technology reducing suffering, saving lives and drastically cutting escalating healthcare cost. There are currently proven methods to activate these natural regenerative life sustaining fields to maintain even restore health. Other studies have also shown that the antiaging telomerase enzyme can be activated using this new Heart Brain Coherence technology to extend life span by actively protecting the telomeres of chromosomes therefore increasing the Hayflick limit of cell division, a biomarker predictive of length of lifespan. The above resources can provide that path to learn and benefit from this practice of self-healing.

V. The Theory of Heart Intelligence by the Founder of Heartmath

"The theory of heart intelligence proposed by Doc Childre postulates that an energetic connection or coupling of information via resonance mechanisms occurs between higher dimensional structures maintained in the quantum vacuum (which are organized in a holographic-like fashion) and the physical DNA in our cells. These higher dimensional structures are proposed to communicate information to the DNA, guiding cell organization and differentiation and setting the boundaries for the individual organism's ability to vary in its physical, mental, and emotional domains." Which has been strengthened by the anatomical discovery of a separate neural network of over 40,000 brain-like neurons in the heart wall that have been shown to retain memory and interconnections with the brain via both direct nerve fibers by the Vagus nerve and electromagnetic waves (EMG) especially during emotional interactions and apparently through guided meditation!

"The electromagnetic field generated by the heart is the most powerful rhythmic electromagnetic field produced by the body. The heart's field permeates every cell and may act as a synchronizing signal for all

the cells in the body in a manner analogous to information carried by radio waves". (Global Coherence) "The rhythmically pulsing waves of electromagnetic energy generated by the heart create fields within fields and give rise to interference patterns when they interact with magnetically polarizable tissues and substances. We have previously shown that cells studied in vitro are responsive to the heart's field". Therefore this represents a type of cellular field entrainment created by the EMG of the heart in the Coherence state measured by heart rate variability (HRV).

"The rhythmic beating of the heart at rest is not monotonously regular, but rather varies dynamically from moment to moment. Heart rate variability (HRV), derived from the electrocardiogram (ECG), is a measure of these naturally occurring beat-to-beat changes in heart rate, which has proven to be particularly valuable in studying the physiology of emotions. The analysis of HRV, or heart rhythms, provides a powerful, noninvasive measure of neurocardiac function that reflects heart-brain interactions and autonomic nervous system dynamics, which are particularly sensitive to changes in emotional states. Our research, along with that of others, suggests that there is an important link between emotions and changes in the patterns of both efferent (descending) and afferent (ascending) autonomic activity. These changes in autonomic activity are associated with dramatic changes in the pattern of the heart's rhythm. Specifically, we have found that during the experience of negative emotions such as anger, frustration, or anxiety, heart rhythms become more erratic and disordered, indicating less synchronization in the reciprocal action that ensues between the parasympathetic and sympathetic branches of the autonomic nervous system (ANS). In contrast, sustained positive emotions, such as appreciation, love, or compassion, are associated with highly ordered or coherent patterns in the heart rhythms, reflecting greater synchronization between the two branches of the ANS".

"At the macroscopic level, the individual DNA molecules are linked through an 'energetic connection' in the form of conventional magnetic fields, which are organized in overlapping patches of cells. As a result, there are networks of groups of cells that form an energetic system. In this model the electromagnetic field produced by the heart acts to bind and synchronize the cells in the body and functions effectively as a modulated carrier wave that organizes the higher-level regulatory functions of the body's energetic system. The heart thus provides the encompassing energetic field that binds the whole system together. This theory also proposes that the heart serves as a key access point through which information originating in the higher dimensional structures is coupled into the physical human system, and that states of heart coherence generated through experiencing heartfelt positive emotions increase this coupling."

These are selected quotes from

Modulation of DNA Conformation by Heart-Focused Intention

Rollin McCraty, Ph.D. Mike Atkinson, and Dana Tomasino, B.A. of the Heart Math Institute.

As you can see there are astounding implications to this science and much of it tested with equally astounding results through the work of Dr. Dispenza. Which is too voluminous to try to summarize in this paper.

VI. Conclusions

The purpose of this paper as stated in the Abstract is that it is my belief that the Cosmic Dark Matter Fractal Field Theory provides a foundational theory to explain how healing fields can be attracted and employed as a natural method of restorative form and function capable of reversing disease and restoring health by accessing a naturally occurring database of all life forms that explain the HeartMath research findings and subsequent health restoring practice of their technology by the followers of the HeartMath institute and many others involved with Dr. Joe Dispenza's work as well as other leaders of this emerging field of Energy Medicine!

Footnotes

1. "Mind fields Consciousness and Biocognitive Morphogenetic Fields as Described by the Great Cosmic Sea and Dark Matter Fractal Field Theory". By T Fulton Johns DDS https://globaljournals.org/GJSFR_Volume18/4-Mind-Fields-Consciousness. pdf
2. "Quantum Scalar Gravity General Relativity, Quantum Mechanics, the Life Force and Multi-Dimensional Motion of Objects within a Cosmic Scalar Flow". By T. Fulton Johns DDS https://globaljournals.org/GJSFR_Volume18/4-Quantum-Scalar-Gravity-General.pdf
3. ORNL Researchers Discover Tunneling State of Water Molecules – AZoM https://usanews.co/ornl-researchers-discover-tunneling-state-of-water-molecules-azom/
4. Modulation of DNA Confirmation BY Heart-Focused Intention, by Rollin McCraty, Ph.D. Mike Atkinson and Dana Tomasino, B. A. www.aipro.info/drive/File/ 224.pdf
5. https://www.heartmath.org/research/research-library/energetics/structural-changes-in-water-and-dna-associated-with-new-physiologically-measurable-states/
6. Modulation of DNA by Coherent Heart Frequencies, Glen Rein*+, Ph.D. and Rollin McCraty+, M.A Institute of Heart Math, Boulder Creek, CA.

7. "Missing Links" Documentary by Gregg Braden Ep7 Black hole fireworks: quantum.
8. Modulation of DNA Conformation by Heart-Focused Intention Rollin McCraty, Ph.D. Mike Atkinson, and Dana Tomasino, B. A. of the Heart Math Institute.
9. Entropy is not a One Way Street https://globalj ournals.org/GJSFR_Volume18/1-Entropy-is-Not-a-One.pdf
10. "The Presence of the Past" by Rupert Sheldrake.
11. http://decathlondentalgroup.com/book-info.html book link and all 8 peer reviewed chapters.

Global Journal of Science Frontier Research: a
Physics and Space Science
Volume 20 Issue 1 Version 1.0 Year 2020
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Quantum Field Theory Free of Divergences

By Yuriy N. Zayko

Abstract- The paper proposes the option of combining gravity and quantum field theory, which avoids the divergences in the latter. The consideration is carried out on the example of calculating the Casimir force between two endless parallel plates for a scalar massive field. The results of traditional solutions containing the divergences of the energy of quantum fluctuations of a vacuum and methods of eliminating them by known ways are presented. It is shown that taking into account the mass of plates, which leads to a curvature of space-time, allows us to obtain the same result without divergence by calculating the Riemann zeta function in the curved metric.

Keywords: quantum field theory, divergences, renormalization, casimir force, metric, riemann zeta function, einstein equations.

GJSFR-A Classification: FOR Code: 020699

Strictly as per the compliance and regulations of:

Quantum Field Theory Free of Divergences

Yuriy N. Zayko

Abstract- The paper proposes the option of combining gravity and quantum field theory, which avoids the divergences in the latter. The consideration is carried out on the example of calculating the Casimir force between two endless parallel plates for a scalar massive field. The results of traditional solutions containing the divergences of the energy of quantum fluctuations of a vacuum and methods of eliminating them by known ways are presented. It is shown that taking into account the mass of plates, which leads to a curvature of space-time, allows us to obtain the same result without divergence by calculating the Riemann zeta function in the curved metric.

Keywords: quantum field theory, divergences, renormalization, casimir force, metric, riemann zeta function, einstein equations.

I. Introduction

Modern quantum field theory (QFT) encounters several difficulties, of which we note the problem of divergences and the problem of quantization of the gravitational field. The first one is that the values for the observable quantities in the framework of the methods adopted in the QFT contain diverging expressions, which requires the use of particular efforts for calculating them. For this purpose, renormalization methods have been developed, the essence of which is to replace the "naked" or "seed" quantities in the final expressions with effective or physical ones. Moreover, all infinities are attributed to the seed (and unobservable) quantities. According to this purely mathematical procedure, all field theories are divided into renormalizable, i.e., those for which this program leads to an acceptable result, and non-renormalizable [1].

The second problem is that the theory of gravity, which is understood as A. Einstein's general theory of relativity (GR), does not allow the renormalization procedure to be applied to it, i.e., GR refers to non-renormalizable ones [1]. As a result, there was a belief that the quantization of gravity requires a specific treatment so that GR can be included in the overall picture of QFT.

This work does not aim to quantize the gravitational field. Instead, a different picture of the combination of QFT with the classical theory of gravity is proposed, which is based on the calculation of formally divergent expressions of QFT in a curved metric as a result of which they obtain finite values. For this, the mass of objects for calculating in the QFT is considered from general relativity as a source of curvature of the space-time metric, and not as a simple parameter of the theory. As a result, the final expressions do not contain divergences, and the renormalization procedure is unnecessary.

The work has the following structure. The Introduction describes the problem and methods for overcoming it. Sections 2 and 3 discuss the calculation of the Casimir force between two parallel plates using traditional renormalization methods using the cut-off factor method and the zeta-regularization method. Section 4 presents the results of the proposed method for constructing a QFT that does not contain divergence. Section 5 is devoted to a discussion of the new vision.

II. Calculation of the Casimir Force between Two Plates

Initially, H. Casimir considered the appearance of an interaction between two conducting parallel endless plates of zero thickness located at a distance d from each other [2]. The force arises due to the shift of the energy of the zero-point oscillations of the vacuum due to the presence of plates. In the following presentation, we will follow [1], according to which we replace the electromagnetic field with a massless scalar field, and instead of the 3 + 1-dimensional problem, we consider the 1 + 1-dimensional one. This does not affect the consideration generality. The plates are located perpendicular to the axis OX at points $x = 0$ and $x = d$. According to [1], the change in energy is equal to

$$\Delta E = \frac{\pi\hbar c}{2d}\sum_{n=1}^{\infty} n \qquad (1)$$

Since the modes are given by the expressions $\sin(n\pi x/d)$ (n is an integer), and the energies corresponding to them are equal $\hbar\omega_n = n\,\pi c\hbar/d$, $\hbar$ – Plank constant, c – light speed. Following the methods of QFT [1] instead of (1) consider $\Delta E(d) + \Delta E(L-d)$, introducing an additional third plate located at $x = L$, $L >> d$. Also, a cut-off factor is introduced into the sum (1) $\exp(-\alpha\omega_n)$, $\alpha\omega_n >> 1$ for $n >> 1$ considering that for high frequencies the plates are not visible. In other words, instead of (1), we have

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$$\Delta E(d)=\frac{\pi\hbar c}{2d}\sum_{n=1}^{\infty}n\exp\left(-\alpha\omega_n\right)=\frac{\pi\hbar c}{2d}\frac{\exp\left(\frac{\pi c\alpha}{d}\right)}{\left[\exp\left(\frac{\pi c\alpha}{d}\right)-1\right]^2} \tag{2}$$

In the limit of small α, an expression for $\Delta E(d)$ looks as follows

$$\Delta E(d)\approx\frac{d\hbar}{2\pi\alpha^2 c}-\frac{\pi\hbar c}{24d} \tag{3}$$

The final expression for the Casimir force has the form

$$\frac{\partial}{\partial d}\left[\Delta E(d)-\Delta E(L-d)\right]\xrightarrow[\alpha\to 0]{}\frac{\pi\hbar c}{24}\left[\frac{1}{d^2}-\frac{1}{(L-d)^2}\right]=\frac{\pi\hbar c}{24d^2} \tag{4}$$

conclusion is somewhat complicated, but it allows one to understand the procedure for eliminating of divergence by subtracting expressions of the analogous structure - α was not included in the final formula.

III. Zeta Regularization Method [3]

Let's consider the 1 + 1-dimensional Casimir problem for a massive scalar field $\Phi(t, x)$ obeying the Klein-Gordon equation [1]

$$\left(\frac{\partial^2}{\partial t^2}-\frac{\partial^2}{\partial x^2}+m^2\right)\Phi(t,x)=0 \tag{5}$$

m – is a mass of the field [4]. Stationary states have the form $\Phi(t,x)=e^{i\omega t}\varphi(x)$, and the spatial part of the field satisfies the equation

$$\left(-\frac{\partial^2}{\partial x^2}+m^2\right)\varphi(x)=\omega^2\varphi(x) \tag{6}$$

ω – is an energy of the stationary state of the field. For the Dirichlet boundary conditions, the wave function has the form $\varphi(x)=\sin k_n x/\sqrt{\omega_n d}$, where $\omega_n=\sqrt{k_n^2+m^2}, k_n=\pi n/d, n=1,2,3...$ In the frame of the zeta regularization method, the diverging expression for the energy of zero vibrations has the form

$$E(s)=\frac{1}{2}\mu^{2s}\sum_{\omega}\left(\omega^2\right)^{\frac{1}{2}-s}=\frac{1}{2}\mu^{2s}\zeta\left(s-\frac{1}{2}\right) \tag{7}$$

Where $\zeta(s)=\sum_{\omega}\left(\omega^2\right)^{-s}$ - the zeta function of the Laplace-type operator on the left-hand side of (6) and the parameter μ with the dimension of mass is introduced so that the quantity $E(s)$ has the dimension of energy.

By some mathematical transformations, which we omit, we represent $E(s)$ in the form ($\beta=md/\pi$) [4]

$$E(s)=E^{div}(s)+E^{ren}(s)$$

$$E^{div}(s)=\frac{m}{2}\left(\frac{\mu}{m}\right)^{2s}\left[-\frac{1}{2}+\frac{\sqrt{\pi}}{2}\frac{\Gamma(s-1)}{\Gamma\left(s-\frac{1}{2}\right)}\beta\right]$$

$$E^{ren}(s)=-m\beta\int_1^{\infty}\frac{\sqrt{x^2-1}}{e^{2\pi\beta x}-1}dx \tag{8}$$

where the diverging and renormalized energy parts $E^{div}(s)$ and $E^{ren}(s)$ are explicitly pointed. The diverging fraction includes the part of the total energy, which is conserved in the classical limit to which corresponds $m \to \infty$. It contains the same divergences as the total energy. Following the renormalization rules, it must be subtracted from the total energy. At small distances between the plates

$$E^{ren}\big|_{md\to 0}=-\frac{m}{24\beta}=-\frac{\pi}{24d} \tag{9}$$

which is the same as the result of the previous calculation using the cut-off factor.

[1] This section uses the Heaviside unit system in which $c = \hbar = 1$

IV. Zeta Function Calculation

Note that if we substitute in (1) the expression for the Dirichlet series for $\zeta(-1)$ ($\zeta(s)=\sum_{s=1}^{\infty} n^{-s}$ – Riemann zeta-function)

$$\zeta(-1)=\sum_{n=1}^{\infty} n=-\frac{1}{12} \tag{10}$$

Then we immediately get the final expression for the Casimir force (4). The sums of divergent series, in particular series (10), are calculated using the Euler-Maclaurin formula [5]. Like other methods of summing divergent series, this one, although it leads to the correct result, leaves some questions unanswered. The same applies to the above methods of renormalization. In particular, it remains unclear why the answer looks that way, and not otherwise. In fairness, one must say that mathematics does not set such a goal. Nevertheless, the answer to this question allows us to find out some details that had not been paid attention to before. Therefore, later in this section, we will try to answer it by turning to the calculation of the zeta function $\zeta(-1)$.

The sum of the Dirichlet series of the zeta function ζ (–1) was calculated in [6]. Series (10) are divergent and, as is commonly believed, have no sum in the usual sense applicable to converging ones [5]. However, this is true only when calculating is performed in a flat space-time metric. Calculation in the curved metric leads to the value ζ (–1) ≈ –0.08035, which coincides with the exact one –1/12 = –0.0833(3) within the relative error of ~ 3.576%. The calculation is performed in the metric (*s* is the interval, *t* is the coordinate time, *K* is the gravitational constant).

$$ds^2=g_{00}c^2dt^2-g_{11}dx^2$$
$$g_{00}=1+\frac{x}{x_c}, g_{11}=g_{00}^{-1}, x_c=\frac{c^2}{4\pi\sigma K} \tag{11}$$

which is created by the gravitational field of an infinite massive plane perpendicular to the *OX* axis with a constant mass density σ.

In other words, in the initial Casimir problem, divergences can be avoided if massive plates are considered from the very beginning. The metric created by two plates has the form [7, 8]

$$ds^2=\left(1+\frac{2x}{x_c}\right)c^2dt^2-\left(1+\frac{2x}{x_c}\right)^{-1}dx^2, x<-\frac{x_c}{2}$$
$$ds^2=\left(1-\frac{2x}{x_c}\right)c^2dt^2-\left(1-\frac{2x}{x_c}\right)^{-1}dx^2, x>\frac{x_c}{2}$$
$$ds^2=c^2dt^2-dx^2, -\frac{x_c}{2}<x<\frac{x_c}{2} \tag{12}$$

Expressions for metrics (11) and (12) are obtained from solutions of Einstein's equations [9]

$$R_{ik}-\frac{1}{2}g_{ik}R=\frac{8\pi K}{c^2}T_{ik}$$
$$ds^2=g_{ik}dx^idx^k \tag{13}$$

g_{ik} – metric tensor, R_{ik} , T_{ik} – Ricci tensor and momentum-energy tensor, $R = R^i_i$, i,k = 0,1. Einstein's equations reduce to a condition imposed on the Ricci tensor $R_{ik} = 0$. The solution of (13) looks as follows[2] $g_{00} = g_{11}^{-1} = C_1x + C_2$, $C_{1,2}$ – constants whose values are found from the relation $g_{00} = 1 + 2\varphi/c^2$ in the region where the gravitational field of the plate is weak, $\varphi(x)=2\pi\sigma Kx$ – Newtonian gravitational potential of the plate. As a result, expression (11) is obtained for the space-time interval. The calculation of ζ (–1) itself requires solving the relativistic equations of motion of the material point

$$\frac{d^2x^i}{ds^2}+\Gamma^i_{kl}\frac{dx^k}{ds}\frac{dx^l}{ds}=0 \tag{14}$$

Γ^i_{kl} - Christoffel symbols [9], using metric (11) with initial conditions determined by the form of partial sums (10) (integer *m* plays the role of time)

$$S_m=\sum_{n=1}^{m} n=\frac{m(m+1)}{2}=S_0+\frac{m}{2}+\frac{m^2}{2}$$
$$S_0=0 \tag{15}$$

which coincide with the distances traveled by the material point moving along a straight line with constant acceleration w = ½ and having in the initial position the speed v_0 = ½ [6].

The value of the Casimir force can be obtained by performing calculations with the metric (12), too, since the solutions of Eqs (14) can be considered on a half-line *OX* limited by a singularity. Let us embed a number line with metric (11) in a manifold of greater dimension - the plane. This allows one to state that [10]

[2] The rest components of the metric tensor g_{ik} = 0.

1. The embedding is possible only for the half-line, limited on one side by the singularity of the metric
2. The embedding plane has hyperbolic geometry

Let us return to the solution of the equation of motion (14). Its solution shows that on the trajectory the condition $v_0 = ½$ cannot be satisfied, so the original task has to be changed. Instead of calculating S_m (15) we calculate S'_m

$$S'_m = \sum_{n=1}^{m}(n-1) = S'_0 - \frac{m}{2} + \frac{m^2}{2} \qquad (16)$$
$$S'_0 = 0$$

Using the Ramanujan summation method, one can show that $S_\infty = S'_\infty + 0{,}5$ [11]. At the starting point on the trajectory $v'_0 = -½$, which is satisfied when $q_0 = x_0/x_c = -1{,}41965$. Strictly speaking, the point x_0 should not be considered the initial, but the final point of the trajectory starting in the singularity $q_c = -x_c/x_c = -1$, thereby placing the initial moment in $-\infty$. The distance traveled by a point from q_c to q_0, which we consider as[3] $-S_\infty = -\zeta(-1)$ is equal $q_0 - q_c + 0{,}5 = 0{,}08035$, which leads to the value $\zeta(-1)$ coinciding with the exact value –0, 0833(3) within the relative error 3,576%.

V. Discussion

As noted earlier, the calculation result of $\zeta(-1)$ can be considered as yet another confirmation of Einstein's general theory of relativity (GR), obtained along with other experimental ones [8]. Its feature is low accuracy compared to the experimental ones. This is due to the approximate nature of metric (11) because when it was obtained, the dependence of the acceleration w in a fixed system on the velocity of the point v was not taken into account

$$w = \left(1 - \frac{v^2}{c^2}\right)^{3/2} w' \qquad (17)$$

Metric (11) ensures the constancy of acceleration in the point's frame of reference w'. The relative smallness of the error is because in the considered section of the trajectory $v/c << 1$ [6].

Despite this, the main goal of the work is achieved - it is shown that taking into account the mass of plates and the resulting space-time curvature allows us to obtain a solution to the Casimir problem without divergences.

It can be assumed that this result can be generalized to other problems of QFT, whose solution in a flat space-time leads to divergences.

As already noted above, the final values for sums of divergent series similar to the series appearing in the Casimir problem are obtained using the Euler – Maclaurin or Abel – Plan formulas [12]. The author's approach allows one to connect these results with the geometric properties of the numerical continuum and speaks of a deep connection between different points of view on the nature of the calculations.

A historical analogy can be drawn with the interpretation of the Lorentz transformations as properties of Maxwell's equations, adopted in the pre-Einstein era and currently as properties of space-time as a whole.

The effect of gravity on the Casimir effect has been considered previously in many works. In [15, 16], the Casimir effect was studied in a weak background gravitational field quadratic in curvature invariants. In [17], the so-called dynamic Casimir effect was investigated associated with the influence of the movement of plates in curved space-time on quantum fluctuations. The smallness of corrections to the classical Casimir effect will require additional experiments on gravitational interferometry to observe them.

The interest in constructing quantum field theory in curved space-time is due to the existence of regimes when the influence of the space-time curvature is significant, and the effects of quantum gravity can still be neglected [18].

VI. Conclusion

The paper constructs a version of quantum field theory in a curved space-time that does not contain divergences. As an example, the calculation of the vacuum energy for a massive scalar field with boundary conditions on two parallel infinite massive plates (a variant of the Casimir problem) is considered. A standard solution to this problem containing divergences in flat space-time is given. Traditional methods for their elimination are considered - the cut-off factor method and the zeta-regularization method. It is shown that the divergences are due to the solution of the problem in neglecting the mass of plates and, as a consequence, the curvature of space-time. It is also shown that the curvature of space-time by taking into account the gravitational effect of the plates leads to the disappearance of divergences.

The result of the work allows us to conclude that the real reason for the appearance of divergences in the QFT is the consideration of problems within the framework of the concept that is called "physics in a box" in the literature, when for the sake of convenience or simplification in the problem to be solved only some features of the phenomenon are taken into account that is important for obtaining an early decisions and features that seem insignificant are discarded [19].

[3] Since the point moves in the direction of decreasing the coordinate q, series' sum $S_\infty = -\Delta q$

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Introduction

FSFRC/ASFRC is the most prestigious membership of Global Journals accredited by Open Association of Research Society, U.S.A (OARS). The credentials of Fellow and Associate designations signify that the researcher has gained the knowledge of the fundamental and high-level concepts, and is a subject matter expert, proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice. The credentials are designated only to the researchers, scientists, and professionals that have been selected by a rigorous process by our Editorial Board and Management Board.

Associates of FSFRC/ASFRC are scientists and researchers from around the world are working on projects/researches that have huge potentials. Members support Global Journals' mission to advance technology for humanity and the profession.

FSFRC

Fellow of Science Frontier Research Council

FELLOW OF SCIENCE FRONTIER RESEARCH COUNCIL is the most prestigious membership of Global Journals. It is an award and membership granted to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Fellows are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Fellow Members.

Benefit

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A FSFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Fellows can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Fellows receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Fellows can use the honored title of membership. The “FSFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., FSFRC or William Walldroff, M.S., FSFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Fellow members of FSFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All fellows get a dedicated page on the website with their biography.

Career | Credibility | Reputation

Future Work

Get discounts on the future publications

Fellows receive discounts on future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Fellows get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows and associates receive access to all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Fellows are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All fellows receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 60% of sales proceeds

Fellows can publish articles (limited) without any fees. Also, they can earn up to 60% of sales proceeds from the sale of reference/review books/literature/ publishing of research paper. The FSFRC member can decide its price and we can help in making the right decision.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Fellow members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

Access to Editorial Board

Become a member of the Editorial Board

Fellows may join as a member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. Additionally, Fellows get a chance to nominate other members for Editorial Board.

Career | Credibility | Exclusive | Reputation

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 5 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 10 GB free secure cloud access for storing research files.

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL

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Organize seminar/conference

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Exclusive

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Earn 30-40% of sales proceeds

Associates can publish articles (limited) without any fees. Also, they can earn up to 30-40% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Associate members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 2 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 5 GB free secure cloud access for storing research files.

Associate	Fellow	Research Group	Basic
$4800 **lifetime designation**	$6800 **lifetime designation**	$12500.00 **organizational**	APC **per article**
Certificate, LoR and Momento **2** discounted publishing/year **Gradation** of Research **10** research contacts/day **1 GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day **5 GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9755896